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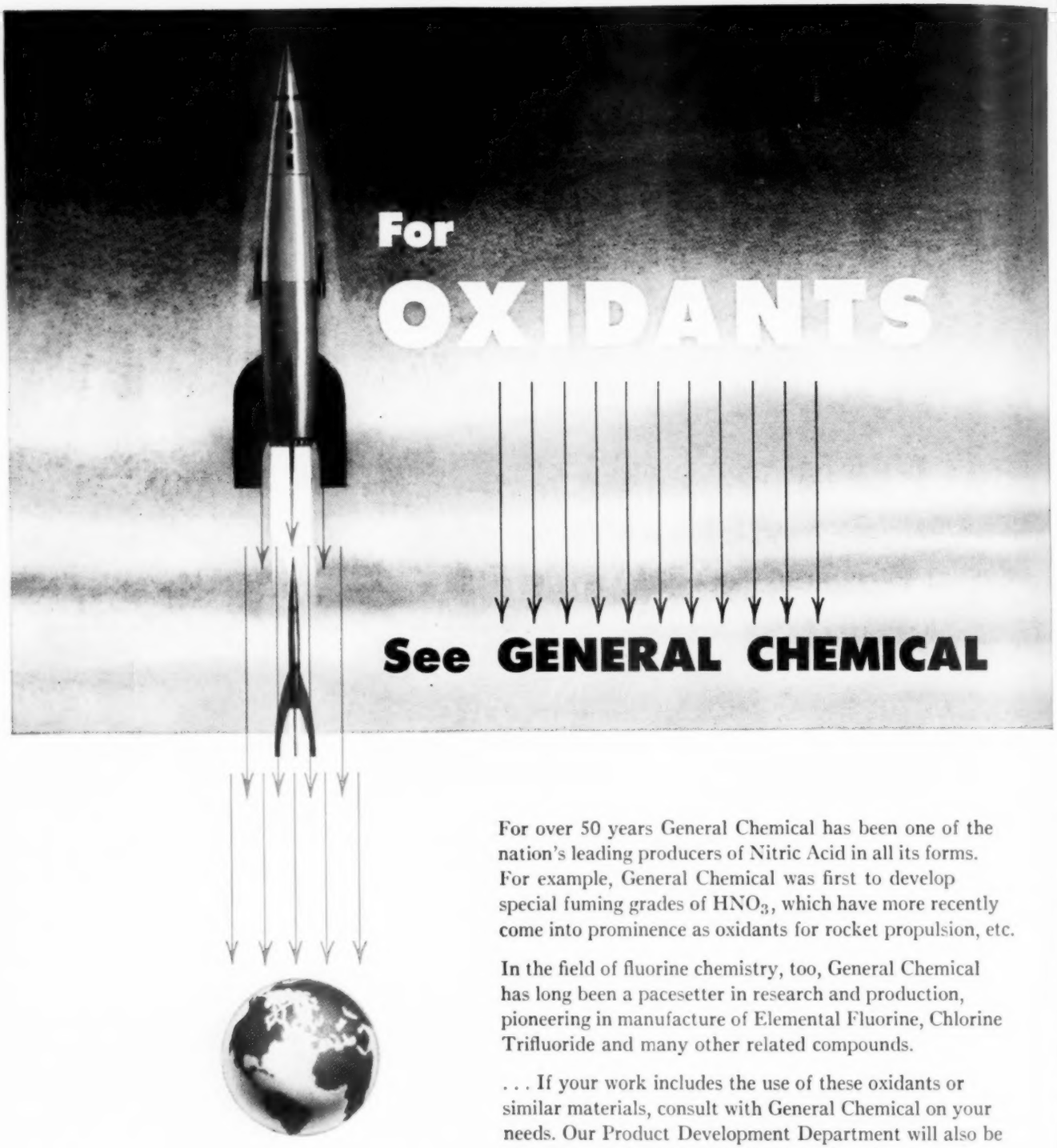

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The Armed Forces Chemical Journal is the official publication of the Armed Forces Chemical Association. The fact that an article appears in its columns does not indicate the approval of the views expressed in it by any group or any individual other than the author. It is our policy to print articles on subjects of interest in order to stimulate thought and promote discussion; this regardless of the fact that some or all of the opinions advanced may be at variance with those held by the Armed Forces Chemical Association, National Officers, and the Editors.

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COVER PHOTO

Tank Mounted Flame Thrower in action. See Story on page 8.

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FROM YOUR NATIONAL PRESIDENT

I appreciate deeply the honor of my re-election as President of the Association for the forthcoming year. I trust that this action by our Board of Directors at the Annual Meeting in New York in May reflects the good-will and approval of our membership generally. For the year ahead, I shall need your active support and assistance.

As many of you know, I had the opportunity recently of visiting a large number of our chapters throughout the country, and thus gained an insight first-hand into their special situations and problems. As a result of these visits, plus close touch throughout the past year with the Executive Committee and the Board of Directors, and finally our stimulating Annual Meeting in New York, my impressions are that the Association has indeed come a long way.

Our programs and purposes are now clearly and soundly established, and I think we can all look forward to a most useful and prosperous future for our organization.

There are three suggestions I would like to put forward to our members, particularly our Chapter officers, for Chapter activity during the present year. These are:

1. Increasing our membership through local membership drives or other means which may appear locally applicable.

2. Bringing home to all members the fact that our quarterly Journal and monthly Chemical News are intended to serve all our members. The Editor is always open to suggestions, and will welcome contributions for publication, both in the form of completed articles on subjects of general military and chemical interest, and letters to the editor—short or long, depending on the views and subject matter to which the writer may wish to give expression.

3. Stimulation of the activities of the Chapters with the view to insuring continued interest of all concerned.

L. W. MUNCHMEYER

COL. JOHN C. MacARTHUR
Editor

Colonel John C. MacArthur, USA (Ret) of Washington, D. C., a charter member of the Association, was appointed Editor of Publications for the forthcoming year at the annual meeting in New York City on May 20. He assumes that position and duties following this issue of the JOURNAL.

Colonel MacArthur, whose last Army assignment was as Chief of the Plans, Training & Intelligence Division, office of the Chief Chemical Officer, Department of the Army, retired in 1951 after more than 33 years service. In World War II he served as Deputy Chief Chemical Officer of the European Theatre of Operations and later as Chief Chemical Officer, Twelfth U. S. Army Group on the Staff of General Bradley. He was awarded the Legion of Merit, the Bronze Star Medal and the Army Commendation Ribbon, the Order of the British Empire and the Croix de Guerre with Palm.

A graduate of the School of Journalism, University of Missouri, Colonel MacArthur engaged in newspaper work in St. Louis, Cleveland and Omaha before entering the Army in World War I as an Infantry officer. His duty assignments between wars include several years in the War Department, two years in the Far East, four years at the American Embassy, London, and tours as instructor at the Chemical Warfare School and the Infantry School. He is a graduate of the Chemical Warfare School and the Command & General Staff college. He transferred to the Chemical Corps (then CWS) in 1928.

COL. RODIER RETIRES; COL. MACARTHUR NEW EDITOR

Lt. Col. Harold B. Rodier, AUS (Ret), is, effective after this issue, relinquishing his post as Editor of the JOURNAL and will retire and make his home in Clearwater, Florida. Prior to his departure for Clearwater, Colonel Rodier has planned to make an extensive tour of the fishing holes of this continent, to extend over a period of about a year.

Colonel Rodier has been the Editor of the JOURNAL since the inception of the Association with the exception of a brief period when Captain Manchester assumed the post. He served in the Chemical Corps (then CWS) from September, 1942, until the close of the War. During this time he served as Chief of I&E Section at Camp Sibert, Alabama, and later as Chief of the Orientation Branch, USA, Mediterranean Theatre of Operations. His previous military service included service on the Mexican border in 1916, and as a member of the 168th Infantry, 42nd (Rainbow) Division during World War I.

Lt. Col. Rodier was awarded the Silver Star, the Bronze Star and the Brazilian Medal of War, and his service medals include the Victory Medal in World War I with five battle stars. He retains his association with the JOURNAL in the capacity of Editorial Consultant.

LT. COL. HAROLD B. RODIER
Retiring Editor

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☆ ☆ ☆ ☆ ☆ ☆ AFCA's 8th

The Armed Forces Chemical Association held its Eighth Annual Meeting on May 20th and 21st, 1953, at the Waldorf-Astoria Hotel in New York City. The meeting was highly successful and General Porter, President of the New York Chapter, and his able staff may well be proud of the success which crowned their efforts. The program of the Annual Meeting was pointed, constructive, and met with keen interest and appreciation by those who attended.

A brief resume of the proceedings at the Meeting follows. The addresses given are recorded in subsequent articles.

Directors' Meeting

The Board of Directors of the Armed Forces Chemical Association met at New York on Wednesday, May 20, 1953, President L. W. Munchmeyer presiding.

President Munchmeyer gave a brief resume of the activities of the Association during the year just past. The reports of the various Officers of the Association were not submitted at this time, being deferred until the first open meeting. The agenda for the Meeting was discussed and a number of pertinent suggestions made by the Directors present.

Mr. Morton Hague submitted the report of the Nominating Committee on behalf of its chairman, General William N. Porter. In the ensuing election, the following officers were elected. President: Col. L. W. Munchmeyer, USAR, Binghamton, New York.

1st Vice President: Rear Admiral Nathaniel S. Prime, USN (Ret.), Frederick, Maryland.

2nd Vice President: (Chairman of Finance Committee) Colonel Robert T. Norman, USAR, Washington, D. C.

Third Vice President: (Chairman of Membership and Organization) Mr. William D. Wilkinson, Chicago, Illinois.

Fourth Vice President: (Chairman of Publications) Mr. Arthur M. Miller, Washington, D. C.

Fifth Vice President: (Chairman of Meetings and Conventions) Mr. Harry A. Wansker, Cambridge, Massachusetts.

Sixth Vice President: (Chairman of Research and Development) Dr. Ralph E. Gibson, Silver Spring, Maryland.

Seventh Vice President: (Chairman War Mobilization Planning) Col. E. R. Baker, Ponca City, Oklahoma.

The meeting of the Board of Directors then adjourned.

Subsequently the newly elected Executive Committee convened to elect the following officers:

Secretary-Treasurer, Mr. Fred M. Jacobs, Washington, D. C.

Assistant Treasurer, Miss Anna A. Holovach, Washington, D. C.

General Counsel, Major Charles E. Pledger, Jr., USAR, Washington, D. C.

Editor and Assistant Secretary, Col. John C. MacArthur, USA (Ret.), Washington, D. C., effective upon the retirement from the office of Editor of Col. Rodier, in July.

Editorial Consultant, Lt. Col. Harold B. Rodier, AUS (Ret.), effective upon his retirement as Editor.

Annual Meeting

The Eighth Annual Meeting of the AFCA convened on Wednesday afternoon, May 20, at 2:30 o'clock, Col. L. W. Munchmeyer, President, presiding. President Munchmeyer welcomed the assembly and extended his warm thanks for the splendid cooperation he had received, during his first year in office, from the membership and the Chapters. He called attention to the outstanding activity of the host Chaper, New York, the Midwest Chapter, the Ft. McClellan Chapter, Wilmington, and Washington, D. C.

He reported on the student award program and the splendid response

President L. W. Munchmeyer entertained the A.F.C.A. members attending the Annual Meeting at a cocktail party preceding the banquet. Shown are Dr. Eugene M. McCauliff, President Munchmeyer, Admiral Archie Conchey, Col. Escude, Mrs. McCauliff, General Porter, and Col. Nutter.

Dr. McCauliff looks over the Chemical Warfare exhibit set up at the Waldorf-Astoria for the National Meeting of the A.F.C.A. by the New York Chemical Procurement District.

throughout the country which this Association activity has evoked.

Secretary-Treasurer's Report

Since the health of our Secretary-Treasurer did not admit of his attending the Meeting, President Munchmeyer asked First Vice President Admiral Prime to render the financial report. Admiral Prime prefaced the report by saying "Mr. Jacobs has not only the respect but the love and affection of all of us who have worked with him on the Executive Committee. He has done a magnificent job. . . ." The report he rendered showed a satisfactory financial position for the Association but reflected a slight decrease in the number of group members. He called attention, in view of the ever increasing activities of the Association in the field of National Defense, to the necessity for increasing our group membership and further strengthening the financial position of the Association.

Editor Retires

At this point, President Munchmeyer called attention to the fact that Lt. Col. Rodier is retiring from service as Editor and will spend the next year or two "travelling and fishing."

He expressed appreciation for the job that Editor Rodier had done for the Association. He introduced Col. John C. MacArthur, who will succeed Col. Rodier in the editorial post.

Midwest Chapter

Mr. Morton Hague, the retiring President of the Midwest Chapter, was called upon to discuss the measures which resulted in such a splendid growth in the numerical strength and the activities of the Midwest Chapter. He ascribed this growth to organization in which every element of the Association was represented and to a sustained and energetic functioning of the various committees comprising this organization. He reported that the twenty-four members of the Chapter's Advisory Committee met regularly, with an average attendance of twenty. The objective of the Chapter, he explained, is to create and maintain an Association that would be of explicit value to its membership. The accent, he said, was on quality of the meetings and the service rendered by the Association. He called attention to attendance at special Chapter functions of from 500 to 750 people. He praised the work of his predecessor as Chapter President, Mr. G. M. Glidden, and declared that his successor, Mr. Lew Terry, would carry the membership and accomplishments of the Chapter to new heights.

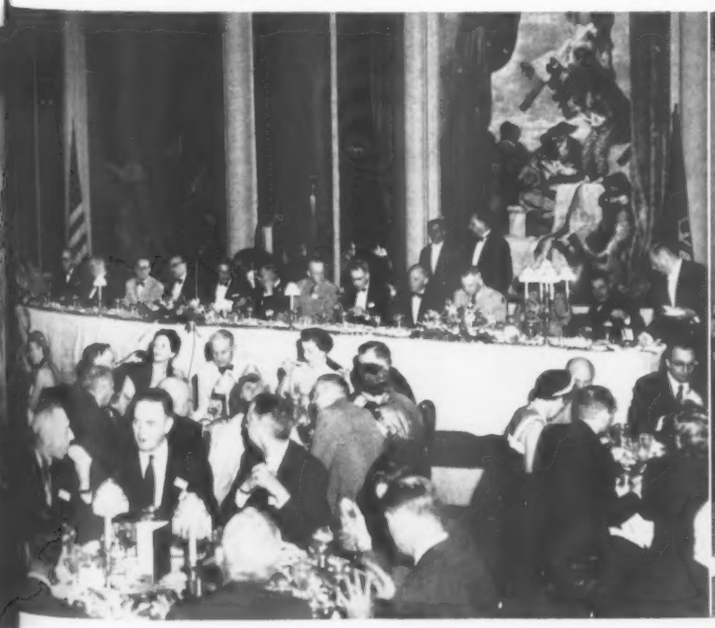
Mort Hague Honored

President Munchmeyer then read to the meeting a resolution which had been passed by the Midwest Chapter, as follows:

"BE IT RESOLVED, That the Midwest Chapter of the Armed Forces Chemical Association gratefully acknowledge the outstanding contribution made by Mort Hague to the Welfare of the Chapter and the Association during the past two years in which he has served as President of the Chapter. The very successful meeting and symposia organized under his direction were of nation-wide interest and contributed greatly to the prestige of the Association. The first national meeting of the Association sponsored by the local Chapter, raised a standard and set a pattern for years to come. In appreciation of these efforts, the Chapter respectfully requests the recognition of his work to be made by the Association during the Annual Meeting, May 20-21, 1953, in

ANNUAL MEETING ☆ ☆ ☆

The Sert Room of the Waldorf-Astoria made a beautiful setting for the A.F.C.A. banquet.



The Directors Met on May 20th

New York City, preferably by the presentation of an appropriate plaque."

Directors-at-Large

Colonel Kuhn reported that a proposed amendment to the Constitution relating to the election of Directors-at-Large will shortly be sent to the Directors. The purpose of the proposed change is to effect an area representation among the Directors-at-Large. For the past two years, such an area representation has been suggested on the official ballot, but was not mandatory. This year because so many nominees for Director-at-Large in the Pacific area appeared on the ballot, the dispersion of votes among these members had the result that no Directors were elected from the Pacific Coast area. Under the proposed amendment, a stated number of Directors-at-Large, proportionate to the membership in the various areas, would be elected on an area basis.

Procurement Questionnaire

Vice-President William D. Wilkinson then reported on a project of the Midwest Chapter designed to be of service both to industry and to the Army. A Committee which he headed prepared a searching questionnaire to be sent to a representative group of bidders on defense contracts. The replies received were pertinent and illuminating. Elsewhere in this issue is published an article by Mr. Wilkinson in which he describes this project and quotes the questionnaire and the replies received.

After an announcement of the election of officers and some further discussion, on a motion of Dr. Lawson the meeting adjourned with a rising vote of thanks to President Munchmeyer for the "grand job he has done this year."

Cocktail Party

At 5:00 o'clock a "get-acquainted cocktail party" was held in the Jansen Suite of the Waldorf. This party began promptly but was somewhat tardy in breaking up and was by no means the least successful event on that day's program.

Thursday Morning Session

The meeting convened at 10:45 a.m., May 21, President Munchmeyer presiding.

A.F.C.A. Safety Award

Col. Kuhn was asked to speak on the presentation of an Armed Forces Chemical Association's Safety Award, established this year, to the Army Chemical Center. Mr. William English, the Safety Director of the Army Chemical Center, accepted the award on behalf of the installation, from President Munchmeyer.

The successful efforts of the Chemical Corps' various manufacturing installations to reduce the incidence rate of accidents makes a story of great interest, which will be carried in an early issue of the JOURNAL.

Technical Manpower Symposium

President Munchmeyer then introduced Dr. Walter E. Lawson, Chairman of the Armed Forces Chemical Association Committee for Technical Manpower. Dr. Lawson, Maj. Gen. William N. Porter (Ret.), Vice Admiral Earle W. Mills, USN (Ret.), Col. Harry A. Kuhn, USA (Ret.), and Col. Oscar C. Maier then conducted a program on the technical manpower problems facing this nation which constituted an important highlight of the Annual Meeting. Their remarks are carried in full elsewhere in this JOURNAL.

Thursday Afternoon Session

The meeting convened at 2 p.m., May 21, President Munchmeyer presiding.

After a warm address of welcome from General Porter, President Munchmeyer opened the symposium on "How Best We Can Mobilize Our Chemical Assets for Defense," by calling successively on the panel speakers, Maj. General E. F. Bullene, Chief Chemical Officer, Department of the Army, who spoke on "Flexibility in Planning." The next speaker was Mr. Howard R. Huston, Vice-President of American Cyanamid, who spoke on "The Chemical Industry—Minute

NEW FACES ON THE EXECUTIVE COMMITTEE

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HARRY A. WANSKER
Fifth Vice President
(Chairman Meetings and Conventions Committee)

Men of Mobilization." The final speaker was Dr. Ralph E. Gibson, Director of Applied Physics Laboratory, Johns Hopkins University, whose subject was "Enhancing Our Potential—Research and Development."

Each of these three splendid addresses is published in full in this issue. Following a brief question and answer period, the meeting adjourned.

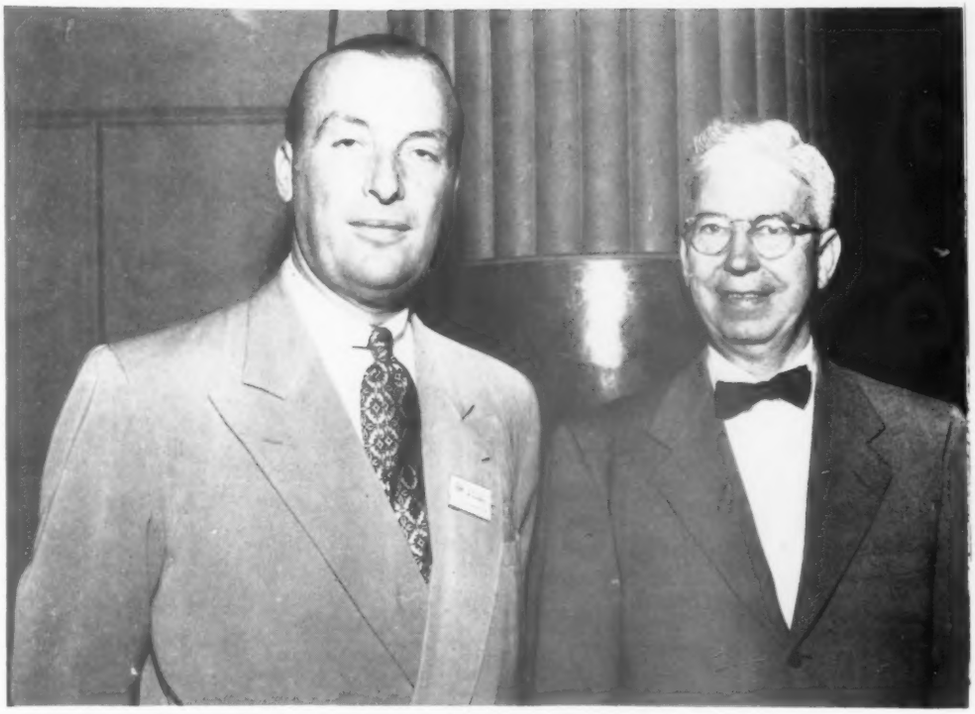
The Banquet

The banquet was held in the beautifully decorated Sert Room of the Waldorf Astoria, following the President's Reception in the foyer of the banquet hall.

Bronze Plaque to President

A handsome bronze plaque commemorating the distinguished service rendered the AFCA by President L. W. Munchmeyer, during his first year of office, was presented on behalf of the Association by Past President Walter E. Lawson.

The principal speaker at the dinner was Mr. Harry A. Winne, Vice-President of General Electric Company, whose subject was "The Atomic Fuel Horizon."



Dr. Eugene M. McCauliff and Mr. Howard McQuaid. Dr. McCauliff was the New York, and Mr. McQuaid the National, Chairman of the Annual Meeting and to them go the thanks of the Association for a brilliantly conducted affair.

Mr. Winne's address is carried in full elsewhere in this JOURNAL.

At the conclusion of the dinner, the fall of President Munchmeyer's gavel closed a brilliant and successful Annual Meeting.

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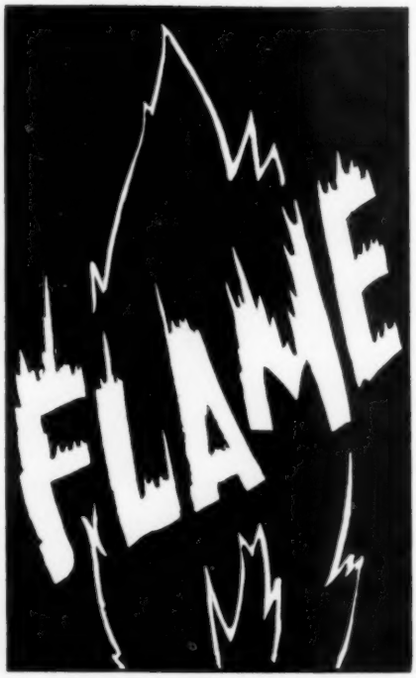


Portable flame thrower in action on Bougainville, March 1944.

By H. GILMAN WING*

Long a weapon of land and sea warfare flame has reached its greatest heights in Korea. Today the UN line stretching 165 miles across the Korean peninsula is protected by thousands of napalm mines and hundreds of emplaced, portable, and mechanized flame throwers. When our troops attack the Chinese burrowed deep in the Korean hills, flame is the weapon which goes down tunnels and around corners to kill the enemy or drive him from his hiding place. Man's fear of fire and the extreme effectiveness of burning napalm are fully exploited by the United States Eighth Army. Chinese and North Korean troops fear and hate our flame weapons.[1]

Although man has used fire in many ways in warfare since the dawn of history, it was not until 1906 that Richard Fiedler, a German engineer, invented the prototype of the modern flame thrower. Upon the occasion of its first use by the German army in World War I the terrifying liquid flame destroyed French machine gun nests near Malancourt Forest. The Allied soldiers soon learned, however, that the range of this flame thrower was extremely limited, and by concentrating their fire on flame thrower operators the Allied troops soon reduced the weapons to a comparatively ineffective status. Indeed, the operation of the flame thrower soon became so risky that the Germans allegedly punished criminals by making them operate the *flammenwerfer*.

All the major powers on the western front produced flame throwers during World War I although there is no record of the American model ever seeing action. Brigadier General Amos A. Fries, Chief, Chemical Warfare Service (CWS), amply expressed the consensus as to the value of flame throwers when he wrote in 1921, "Taken all in all, the flame thrower was one of the greatest failures among the many promising devices tried out on a large scale in the war." With this in mind the success of the flame thrower as a weapon in World War II and Korea is all the more amazing, and much credit should be given to the engineers and chemists who worked on the task.

The period between the First and Second World Wars witnessed little advance in the development of flame throwers. The Italians did create something of a sensation in 1937 when they demonstrated flame throwers mounted in combat cars. In the United States, development work on a flame thrower to be mounted in a tank, as well as a portable flame thrower, was authorized in 1940 and the responsibility for the projects was given to the Chemical Warfare Service. Our intelligence reports from Germany and Italy indicated that those nations had already used flame throwers on a limited scale, an outstanding example of which was the successful German assault on the Belgian Fort Eben Emael in May, 1940. During the years 1940 and 1941, while the war crept closer to our shores, the CWS developed an experimental model of a portable flame thrower which was standardized just a few months before Pearl Harbor. This portable flame thrower, which consisted of two fuel tanks, a pressure cylinder and a flame gun, weighed some 68 pounds when filled with 5 gallons of fuel and shot blazing gasoline for about 25 yards with a firing time of eight to ten seconds. The limited range and the vulnerability of the electrical ignition system to the slightest trace of moisture made this model unsatisfactory. With the successful development of a satisfactory means of thickening gasoline and slight changes in the flame thrower in 1942, the effective range of the portable flame thrower increased to 35-50 yards. The thickening agent, known popularly as napalm, gelled the gasoline to a honey-like consistency. Unfortunately the defects in the ignition system were not corrected, and it was not until 1944 that the M 2-2-portable flame thrower appeared which used a cartridge type ignition system in place of the unsatisfactory electrical ignition.

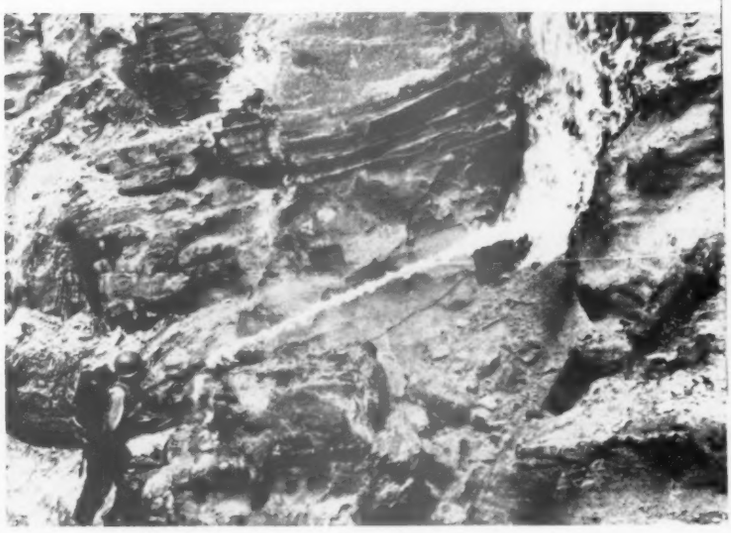
While the development of tank-mounted flame throwers was authorized as early as May, 1940, the mechanized flame thrower did not arrive on the battlefield until some time after the appearance of the portable flame thrower. While the latter had proved effective when the operator managed to creep within range of a pillbox or cave, too often the heavily burdened operator became a casualty to enemy fire. In addition the short range and low fuel capacity of the

[1]The use of flame from the air has already been covered by Lt. (now Capt.) Earle J. Townsend, Cml C, "They Don't Like 'Hell Bombs' ", in *Armed Forces Chemical Journal*, Volume IV, No. 3, January 1951.

* Member of Historical Office Staff, Office Chief Chemical Officer, Department of Army.

A portable flame thrower burns out a Jap pillbox on Saipan, June 1944.

A Jap cave flamed on Iwo Jima, February 1945.



portable flame thrower exposed the operator for a longer period of time yet gave him only a limited period of fire. The answer to this problem appeared to be the mechanized flame thrower where the tank armor could protect the operator and there was room for more flame fuel. Prior to Pearl Harbor, development of the mechanized flame thrower consisted of replacing the tank's cannon with the flame thrower thus making the latter the principal armament. However, no mechanized flame throwers were available to troops in the field for two years after the start of the war. As a result, attempts were made in the Pacific during 1943 to mount portable flame throwers inside light tanks in place of the bow machine gun. Unfortunately, the fragility of the flame thrower and the small fuel capacity of the weapon still constituted serious defects, although the problem of protecting the operator was temporarily solved.*

A shortage of tanks in 1943 caused development interest in the United States to shift from a main armament flame thrower to one used as an auxiliary flame thrower, with a 25 to 50 gallon capacity, interchangeable in a minute with the bow .30-caliber machine gun. A fairly successful model with a range of 50-70 yards was evolved (M3-4-3) of which the CWS produced some 1700 by the end of the war. When no mechanized flame throwers seemed forthcoming from the United States in the early months of 1944, the Chemical Section, Central Pacific Area, produced their own by mounting modified Canadian Ronson flame throwers as the main armament in 24 light tanks for use by the 2d and 4th Marine Divisions in the Marianas Campaign.

In the meantime the portable flame thrower had become an indispensable weapon for our forces fighting the fanatical Japanese. The determination of the Japanese soldier to defend his bunker or cave and inflict casualties long after a military decision had been reached pointed out the need for flame throwers to kill him or force him into the open. The first successful employment of the portable flame thrower by American troops took place 15 January 1943 on Guadalcanal, where the Japanese 2d Division was holding the coastal sector about 5½ miles west of Henderson Field. There under cover of rifle and BAR fire, two Marine combat engineers crawled through dense underbrush in the wooded ravine and poured flame into a Japanese bunker which had impeded the advance of the 8th Marine Regiment. When the infantry advanced they found five dead Japs in the bunker and two who had managed to get a few feet outside before burning to death.

The Japanese hitherto had held prepared positions so doggedly that our initial success in the use of the portable flame thrower gave flame a great boost in the Pacific. Here was a weapon which, when properly employed, would either burn the Jap to death in his bunker or force him into the open where regular infantry weapons could speedily eliminate him.

Our forces experienced a great deal of difficulty in using portable flame throwers in the Pacific because of climatic conditions. The lack of waterproofing, rapid deterioration of batteries, leaking pressure cylinders, and general corrosion due to the damp tropical weather caused frequent malfunctions of the flame thrower. Another recurring problem was the lack of understanding among infantry commanders of the proper tactical employment of flame throwers. The correct tactical doctrine envisaged the use of flame thrower teams of two men as part of an especially trained assault party. The tactics further contemplated that the portable flame thrower would **not** be used as a weapon of opportunity or without proper supporting fire.

At Buna-Gona, Tarawa, Manus, and Bougainville, portable flame throwers aided in digging out or killing the stubborn Japanese defenders. An excellent example of portable flame thrower employment took place in the SWPA some time after the 163d RCT, 41st Inf. Div., had landed in mid-May at Arare, New Guinea, opposite Wakde Island which was to be developed as an air base. When the 1st Infantry, 6th Division, took over the offensive in June, 1944, to secure Maffin Bay, they encountered determined resistance from Japs holed up in numerous coral caves and bunkers. A platoon from the 1st Infantry, while on patrol east of the Tirfoam River, ran into three Japanese bunkers and was promptly pinned down by the enemy fire. When the platoon leader called for aid a second platoon and three medium tanks advanced. The tanks fired several rounds at the largest bunker but failed to silence the position. A Jap sniper killed a tank

*See "Flame Throwing Seabees" in July, 1948 *Journal* by Col. Unmacht.

commander, and the three tanks immediately buttoned up and withdrew.

At this point Lt. Theodore Frankel, leader of the Regimental Anti-Tank Platoon, took a portable flame thrower and crawled across a little clearing to a thick log perhaps 15 yards from one of the bunkers. While the infantry covered the bunkers with BAR and LMG fire Lt. Frankel crept to a little ravine at the right of the largest pillbox and from there fired a short burst of flame into one port. He then crawled to the left, flamed a second opening and heard screams from the occupants. Turning his attention to the center bunker the lieutenant gave it a four-second burst. Although the portable flame thrower was nearly empty Lt. Frankel prepared to flame the third bunker only 10 yards away. The sole Jap occupant committed suicide even though the flame fell short.

Despite frequent malfunctioning our troops continued to use the portable flame thrower throughout the South and Southwest Pacific Areas during 1943 and 1944. In the central Pacific it accompanied its big brother, the mechanized flame thrower, into the Marianas. When Army and Marine forces from the Central Pacific Area poured ashore in the Palaus Islands, the 1st Marine Division brought with it six Navy flame throwers mounted on LT's. Not until the third day after the landing did these amphibious vehicles see action, but thereafter they were employed almost continuously for the next thirty or forty days in neutralizing caves, pillboxes, and dugouts, and also to burn the cover from an area. In the early part of the operation the flame vehicles usually worked ahead of the infantry, and even ahead of the tanks by as much as 200 yards. Unfortunately when the advance reached the hills the vulnerability of the light, half-inch armor plate, and the rugged terrain combined to limit the use of these flame throwers.

There was little chance to use flame throwers in street fighting in the Pacific War until the invasion of Luzon in January, 1945. Then the 37th Infantry Division made considerable use of portable flame throwers in reducing the old Walled City in Manila as well as the Philippine General Hospital. In the latter action the 2d Battalion, 148th Infantry, used six flame throwers to occupy the ground floor of the hospital and executed two other successful flame missions in clearing the second and third floors.

For the Iwo Jima campaign the Marines not only planned to employ portable flame throwers but also eight medium tanks equipped with the modified Ronson flame thrower which had a fuel capacity of 275 gallons. On 19 February 1945, the 4th and 5th Marine Divisions landed on the south coast of the volcanic island of Iwo Jima while the 3rd Marine Division remained in floating reserve. Both assault divisions had four of these main armament flame throwing tanks. The difficult terrain and intense enemy fire prevented much use of the mechanized flame throwers for several days but by D + 6 there was more than enough work in flaming enemy caves and bunkers. The northern area of the island was broken up by deep gullies, saw-toothed ridges, sheer cliffs, and deeply-eroded, boulder-strewn plateaus where the Japanese dug in for their last desperate stand. During the final two weeks of the campaign progress here depended upon the speed with which roads could be cut. Usually a tank dozer would nudge out a few yards of roadway and move aside. Then the flame tanks advanced, sometimes two or three in rapid succession, and fired on the area while the regular tanks stood by to cover them from suicide attacks. On some days the 5th Marine Tank Battalion expended as much as 5,000-10,000 gallons of thickened gasoline. Although the 4th Marine Division had twenty-four auxiliary flame throwers (M3-4-3) in addition to the four main armament flame tanks their after-action reports emphasized the greater effectiveness of the main armament type.

At the same time that it prepared the eight flame tanks for the Marines, the Chemical Section, Pacific Ocean Area, also readied 54 main armament flame tanks for the use of the 713th Medium Tank Battalion in the Okinawa operation with the U.S. Tenth Army. These flame tanks were divided up among the divisions so that three flame tanks operated with each regular tank platoon in support of an infantry battalion. The terrain of Okinawa offered numerous natural advantages to the Japanese defenders. Cave defenses set in the cliffs, escarpments, and hills were plentiful and so situated as to cover all the approaches with interlocking fire. In addition the Japanese troops had ample artillery of large caliber to support their defense lines.

The Japanese forces defending Okinawa experienced their first terrifying contact with mechanized flame throwers on D + 18 (April 19, 1945) when 31 flame tanks expended 3,500 gallons of napalm. Regular tanks led the attack on a hill known as Rocky Crags which rose some 460 feet above the surrounding terrain and covered the approaches to Hill 178 and the high ground west to Tanabaru. Flame tanks and infantry of the 7th Division followed close behind. Although the tanks flooded the peak with flame, the enemy fought bitterly, and not until D + 23 (April 24, 1945) did the Rocky Crags finally pass into our hands.

Rains during May slowed the Tenth Army advance in the gummy mud as much as did Japanese resistance. In early June the skies cleared over Okinawa, and beginning on the 9th of June there occurred a battle in which flame played a typically important role. Facing the XXIV Corps on its 6,000 yard front was a strong rocky line running from Yuza-Dake on the west to Hill 95, its eastern anchor. At least 11,000 troops of the Japanese 32d Army defended the whole line and the U.S. 7th and 96th Infantry Divisions made little progress in their first attack. The following day, June 10th, naval gunfire and artillery pounded the cliffs, but the 7th Infantry Division advancing upon Hill 95 met accurate machine gun and sniper fire from at least 500 Japs deployed in depth in that section of the rugged escarpment. Five flame tanks then maneuvered into position and burned the underbrush from all the approaches to Hill 95. Finally two skeleton companies of infantry struggled to the top of the escarpment, only to be pinned down by enemy fire from farther up the ridge line. Captain Tony Niemeyer and two men of Company C, 713th Tank Battalion, scaled the ridge, pulling a 200-foot fire hose after them. With this hose which was connected to their flame tank, they were able to burn out the Japanese defenders and to kill 70 of them.

Flamethrowing tank burns enemy defenses on Hill 178, 21 April 1945.

The next day all attacks were resumed and much of the success was due to the work of the flame tanks which burned underbrush and flushed the enemy troops from entire areas. On 12 June 1945, two flame tanks moved into the front lines, and an extension hose was hauled up a 50-foot high section of the rocky escarpment by means of a rope. A tank crew fired the flame over the opposite edge where it was blown by the wind into the caves on the reverse slope. By moving the hose from one flame tank to another the men destroyed ammunition dumps, fortified positions, and a large number of Japanese troops. The same afternoon five flame tanks lined up at the base of the cliff and fired on caves in its face. The infantry pushed slowly forward, and by 1600 hours Hill 95 was entirely ours. Although some mopping up remained to be done, the battle for Hill 95 was over, a typical struggle on Okinawa in which flame tanks helped tip the scale.

In the war against Germany and Italy flame did not play as important a role as it did in the Pacific. In the North African campaign each combat engineer battalion carried 24 of the early model portable flame throwers but did not use them. They were used once in Sicily to burn off a field, but at the close of the campaign in August, 1943, the engineers recommended that the portable flame throwers not be taken on future operations. Instead, they suggested the portable flame throwers be left in army supply dumps as Class IV items. Although the recommendation was disregarded, the U.S. Fifth Army in Italy resorted to portable flame throwers only as a desperation measure even when deadlocked with the Germans along the Gustav Line. One such instance occurred during the bloody fighting at Tremensuoli by the 85th Infantry Division when the II Corps cracked the Gustav Line in the advance on Rome. On 11 May 1944 the 1st Platoon, Company G, 339th Infantry, attacked west along the Capo d'Acqua Creek and was halted on the reverse slope of Hill 79 by a series of 15 enemy bunkers defended by two companies of the 274th Grenadier Regiment. After two weary days the platoon leader, 2d Lt. Robert Waugh, obtained a portable flame thrower and formed an assault party. As the regular flame thrower operator had become a casualty in the fighting, Lt. Waugh detailed Sergeant Fred Juliano to make the flame attack. While covering fire kept a key pillbox sealed up, the sergeant crawled along the rocky ground to within 15 yards of the fortification. Then with three short bursts of flaming napalm, he killed all the occupants. The platoon then stormed the remaining pillboxes with WP grenades and continued its advance. For this flame action Sergeant Juliano received the Distinguished Service Cross.

Each American assault division which landed on the coast of France on D-Day carried 150 portable flame throwers, but the type of opposition encountered was not favorable for flame attack. The hedgerow fighting in Normandy saw several attempts to use portable flame throwers, and the weapon was especially helpful in reducing enemy pillboxes and strongpoints. In the hedgerows themselves a mechanized flame thrower would have been more useful than the portable type had it been available, as an unprotected operator found it difficult to approach any German position which had a wide field of fire. An example of the value of the portable flame thrower in street fighting took place when the 23d Infantry, 2d Division, was checked by a series of sandbagged and heavily defended houses on the outskirts of the little Norman town of St. Germain d'Elle on 8 July 1944. An assault party of two portable flame thrower teams, four BAR men and four riflemen worked in close and poured flame in through the house windows. The enemy evacuated the positions immediately.

In the fighting to breach the Siegfried Line the portable flame thrower did not see much action. The careful construction of the German bunkers with interlocking fields of fire

Tank flame thrower mops up Jap cave, 25 June 1945.

hindered considerably the effective use of portable flame throwers. The primary reason for not employing portable and mechanized flame throwers, however, was the belief that artillery and other regular weapons could do the job from a greater distance and with less risk.

Only auxiliary mechanized flame throwers were used by American forces in the ETO, and these did not reach the theater in any number until the latter part of October, 1944, after the Germans had been driven back to their frontier in many places. By the time these auxiliary flame throwers were installed and tank crews trained to operate them our troops went on the defensive for the Battle of the Bulge. When the Allied armies resumed the winter offensive the American troops used artillery to smash Siegfried Line pillboxes followed by regular assault parties using WP grenades and demolition charges. Occasionally our tankers poured flame on such varied targets as pillboxes, trenches, and houses. The tendency of the German soldier to surrender when further fighting was futile was in sharp contrast to the suicidal Japanese behavior in the Pacific.

The only large capacity mechanized flame throwers employed by our armored forces in Europe were four Sherman-crocodile flame throwers which consisted of Sherman tanks with a British "crocodile" flame thrower mounted inside the tank and a trailer of fuel towed behind. The 739th Tank Battalion used these flame tanks to capture the 16th century citadel at Julich, Germany, during the First Army's advance to the Rhine. The attackers planned to flame the south wall from across the old moat and then shell the steel gate. Although two flame tanks developed engine trouble the other two spouted flame over the wall of the citadel and forced the German defenders underground. Twenty rounds of HE then sufficed to smash the steel door and permit the tanks to scour the courtyard with burning fuel. The last German defenders fled just as men from the 175th Infantry, 29th Division, crossed the moat and entered the burning citadel.

The lack of adequate technical and tactical training in the use of the mechanized flame thrower as well as the more or less open terrain further hindered its successful employment in the ETO.

Japanese efforts to defend their island and jungle positions to the last provided us with many lucrative portable and mechanized flame thrower targets. In Europe, however, a considerable portion of the fighting took place in areas where the prevalence of open terrain enabled the Germans to cover the approaches to their positions with extensive

fields of fire. Flame thrower operators were often cut down before they could lug their heavy weapons within range. As a result of these conditions, combined with the average German soldier's willingness to surrender when a battle decision was reached, the flame thrower never had the appeal in Europe that it had in the Pacific.

The outbreak of war in Korea found comparatively few portable and mechanized flame throwers with the occupation divisions in Japan. Since June, 1950, however, flame has steadily grown in importance and today occupies an increasingly important position both on the offensive and on the defensive. The first American tanks equipped with flame throwers to reach the Korean front carried painted pictures of large tigers on the front. After some of these 'Tiger' Tanks ran about 200 North Koreans up a ravine, and annihilated them the North Koreans regarded these tanks with terror, and it became customary for our forces to paint tigers on **all** our tanks whether flame thrower equipped or not. Thus the psychological value of flame has been tremendous. One army tank equipped with the M3-4-3 auxiliary flame thrower went into a Korean valley and fired a single burst of flame. For a distance of over 1,000 yards all the enemy ducked down in their foxholes and ceased firing. This included even enemy troops high on a hillside where the tank could not possibly have reached them.

The surging back and forth of the battle-line brought novel as well as conventional uses for flame. As early as August, 1950, the 1st Battalion, 5th Cavalry, learned to use portable flame throwers to burn Korean villages into which North Korean soldiers had infiltrated during the night. Ordinary burning had failed to deny the enemy the use of the house cellars because the mud walls would remain standing. The napalm from the flame throwers, however, generated enough heat to crumble the crude mud walls, causing them to collapse and fill the cellars. By that September the Republic of Korea (ROKA) troops had resorted to flame throwers both to flush the enemy from dug-in positions and also to break up 'banzai' attacks. This latter use was to prove increasingly important as the months passed. When we were on the defensive, the 25th Infantry Division employed portable flame throwers to stage a night ambush. They placed two flame throwers on opposite sides of a gulch leading up the side of a hill held by our troops. During the night the enemy attempted to use the gulch as a covered approach in an effort to capture the hill. When the leading elements of the enemy file were at point blank range both flame throwers fired. Completely disorganized, the enemy survivors withdrew.

28th Infantry Division cleans up German pillbox, October 1944.

When the 1st Marine Division made an amphibious landing at Inchon on 15 September 1950, its organic tank battalion included several large capacity flame throwing tanks. The Marine tankers used these big flame throwers in the crossing of the Han River and in the capture of Seoul. Against entrenched positions and for cleaning out buildings in street fighting the flame tanks were most successful both in destroying North Koreans and in demoralizing them, for large numbers of North Korean soldiers surrendered following the use of flame. The 105-mm howitzer mounted coaxially with the flame thrower provided extra fire support when needed.

In the rapid advance of UN forces to the Yalu in 1950, and subsequent withdrawal after China entered the war, there was little opportunity to use flame. After the line was stabilized, however, increased use of portable and mechanized flame throwers was made. On 24 March 1951, the 1st Battalion, 15th Infantry, 3d Division, attacked an enemy hill position some 2,000 yards north of Uijongbu. An elaborate enemy dugout situated at the base of the hill impeded the further progress of the battalion. Although our tanks shelled the enemy bunker when our infantry closed in they were driven back by hand grenades. Then the division chemical officer, Lt. Col. James E. Rogers, delivered three portable flame throwers to the battalion. When a flame thrower operator fired bursts of flame into all three openings in the bunker a lone Chinese infantryman emerged with his clothing on fire and was cut down by small arms fire. No further enemy activity came from that bunker. As the 1st Battalion continued the attack up the hill a portable flame thrower fired short bursts of flame into the foxholes which dotted the slope. Although many of these were unoccupied the sight of the flame apparently broke the enemy's nerve, for they scrambled out of the occupied foxholes and attempted vainly to escape to the rear. The 1st Battalion estimated that 40 Chinese soldiers were killed or captured in this operation due to the use of the flame thrower.

The knowledge that the Chinese planned a spring offensive in 1951 led the UN forces to consider seriously the defensive potentialities of flame. In addition to the portable and mechanized flame throwers which were already available, our forces improvised a flame "fougasse" consisting of a 55-gallon drum filled with napalm and installed in various ways as the terrain dictated. Some had explosive charges placed to blow the drum 10 - 20 feet into the air before a secondary charge shattered the drum and ignited the napalm. Others were placed in banks so they would belch flame horizontally through defiles by means of a TNT charge at the base of the drum. A variation of this weapon was improvised by our forces in the form of a 5-gallon napalm land mine. When this fiery munition was detonated, either electrically or by an enemy stumbling over a trip wire, it covered an area some 30 yards in diameter with the sticky gobs of burning napalm. As an additional advantage in night defense the enemy troops could be silhouetted against the flames from this mine and shot down by machine gun and rifle fire. In order to supplement still further the regular weapons on our defense line stretching across the unbelievably rugged terrain of Korea, emplaced flame throwers have been improvised from portable and mechanized flame throwing equipment. Mechanized flame throwers were taken from tanks and the fuel and pressure containers installed below ground level on the reverse slope of hills or in other defiladed positions. From there a lengthy hose attached to a portable flame thrower gun permitted the installation of a flame thrower of large fuel capacity on forward slope defense positions.

There has been no end to American ingenuity in flame

weapons. Some new ideas include the Husch flare which provides easy battlefield illumination and napalm satchel charges which are used by the infantry in assaulting enemy trenches and bunkers.[2] The latter device consists of an empty .50-caliber machine gun ammunition box filled with napalm and ignited by a WP grenade. After the safety pin is pulled on the grenade the satchel charge is hurled into the enemy bunker. In one instance last August, elements of the Greek Battalion employed these satchel charges on enemy bunkers and inflicted 20 casualties.

Perhaps the most spectacular and effective ground flame weapon in Korea today, however, is the large capacity flame throwing tank in use by the Marines and the Army. One night last summer elements of the 1st Marines supported by a Marine Tank Company attacked Hill 122 in the 1st Regiment sector. The objective of this attack was the seizure and occupation of Hill 122 which commanded the reverse slope of Hill 58A because three previous infantry assaults on Hill 58A had failed to dislodge the enemy from that area. The plan of attack envisaged the use of flame and regular gun tanks making a diversionary effort toward Hill 58A while an infantry company seized Hill 122. The diversionary attack on Hill 58A jumped off at about 2030 hours, and darkness forced the four flame tank commanders to light their way to the objective with occasional short bursts of flame. The gun tanks flicked their fighting lights on and off at short intervals in order to locate the prescribed target areas. Upon reaching their objective the four flame tanks, working in pairs, scorched the topographical crest and reverse slope of Hill 58A, at the same time sweeping the area with machine gun fire to discourage attacks on the tanks and inflict maximum casualties on Chinese soldiers forced from their positions. The main infantry assault on Hill 122 began at 2305 when the diversionary attack was most intense and the Marines successfully occupied the hill. Afterwards they reported that the psychological and casualty effect of the flame tank seemed a tremendous factor in the success of the operation.

Not long ago the 5th Marines made a highly successful combined ground, air, and armored raid on two enemy hills on the western front. The plan called for a feint by gun and flame tanks on enemy positions to the west of the objective area while two reinforced platoons of infantry hit the enemy on Hills 31 and 31A at 0800 hours. In the attack three platoons of tanks crossed the MLR at H — 50 and at H — 35 began the assault of the feint area accompanied by heavy false artillery preparation and two air strikes on the real objective. At H-hour the four flame tanks reached the enemy trenches on Hill 35A and commenced burning them. As the first section (two flame tanks) neared its objective the battle haze created by dust and smoke from exploding shells was blown over the objective by a shift in the wind. As this haze rolled over the target it obscured visibility to such an extent that the supporting gun tank platoon and the 2d section of flame tanks were unable to see the 1st section. When the 2d section moved up close again and saw the first two flame tanks the platoon leader's tank was observed to fire a short burst of flame, back down about ten feet, and halt with the body of the platoon leader hanging out of the open hatch. The other flame tank of the 1st section meanwhile poured flame into the trenches connecting Hills 35 and 35A. When three Chinese emerged from a hidden bunker and tried to mount the disabled flame tank they were cut down by a burst of flame from one of the tanks in the 2d section. An enemy rocket team which attempted to take the tanks under fire from the right front was engulfed by a

[2] The Husch flare was named for its inventor, Lt. Charles E. Husch, formerly of the 25th Infantry Division. This flare is made from 81-mm shell containers filled with napalm set off with trip flares. For details see "Improvised Illumination," by Pfc. Cleve Cunningham, in *Combat Forces Journal*, Vol. 3, No. 7, Feb. 1953.

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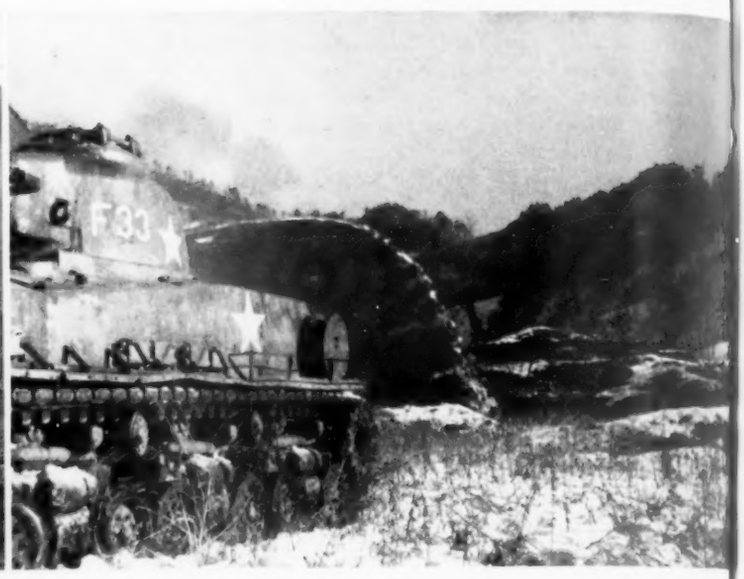

Large capacity flame tank spurts blazing napalm on an enemy bunker.

burst of flame. Other rocket teams which did not hesitate to advance into machine gun fire or proximity fuzed artillery fire beat hurried retreats when the flame throwers were fired at them. The three remaining flame tanks continued to fire bursts at the enemy trenches and at Chinese troops attempting to close in on the disabled tank. In our withdrawal the Marine tankmen managed to evacuate the disabled tank, but in doing so the platoon sergeant's tank was hit and burned although the crew piled out of the tank safely.

While this feint was successfully distracting the enemy's attention the 1st Battalion, 5th Marines, crossed the line of departure and raced through previously cleared mine trails, across the rice paddies, and up the objective hills. The enemy there numbered approximately 100, divided about equally between the two infantry objectives. The Chinese soldiers were well protected in deep trenches, caves, bunkers, and spider holes on both forward and reverse slopes and the two hills were connected by a trenchline varying in depth from 3 - 12 feet. The caves were large and very deep so that on several occasions the Communist soldiers continued to throw grenades even after satchel charges were hurled into the cave entrances. The Marines found four portable flame throwers carried by the assaulting troops to be the most effective means of neutralizing the caves. Two counterattacks were beaten off, and the Chinese did not succeed in re-occupying the two hills until immediately following the Marine withdrawal to our MLR. There were 40 enemy counted KIA and 30 more estimated KIA, while casualties inflicted by tanks, air, artillery, and mortar fire were conservatively estimated at 320 dead.

Flame continues to occupy an important position today in Korea. Report after report indicates that the Chinese hesitate to attack our lines wherever flame throwers are emplaced, and flame continues to uphold the high reputation it won in the Pacific during World War II as a means of rooting out an enemy holed up in bunkers and caves. When the development work is completed on such flame weapons as the Army's new mechanized flame thrower, which includes a towed trailer carrying hundreds of gallons of napalm, the Communists can look forward to an even hotter time from flame in Korea.

U. S. Marines burn Korean village to deny cover to the enemy.

A portable flame thrower squad from the 7th Infantry Division moves up to the front.

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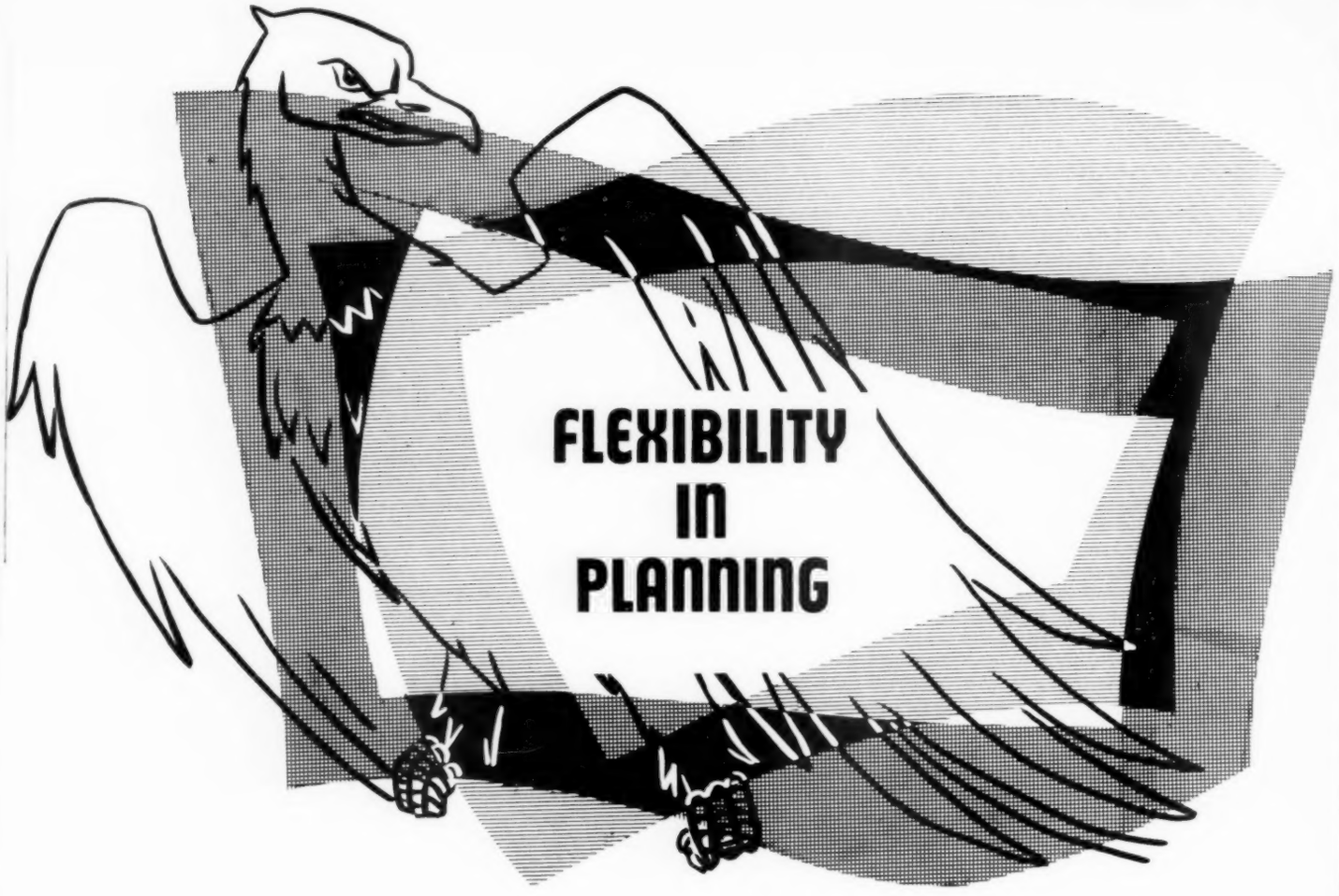

By MAJ. GEN. E. F. BULLENE
Chief Chemical Officer, Department of the Army

GEN. BULLENE

Address delivered at Armed Forces Chemical Association Annual Meeting—May 21, 1953—Waldorf Astoria, New York City.

President Munchmeyer sometime ago very kindly asked me to say a few words at this meeting. I asked him what he would like to have me speak about, and he said he would leave that to me. I then asked Dr. Walter Lawson, our past president, what subject he thought would be of interest to this gathering, and he was just about as helpful.

The AFCA Journal then came out, and in its announcement of this meeting said among other things, — "2:00 p.m. — the roles each of us must play in the new MIG program will be outlined by three hard-hitting spokesmen from Military, Industry, and Government."

I think you will agree that this sounds something like the announcement of next week's main event at Madison Square Garden.

As a matter of fact, I used to box some myself. However, I was cured some thirty-odd years ago at the Olympic Club in San Francisco when inadvertently, and through mistaken identity, I got into the same ring, and at the same time, with the "then NAA heavy-weight champion." He had just returned to San Francisco from having won the national championship here in New York with a first-round knockout.

After that I went in for refereeing—I found I could keep out of the way of two fighters in the ring better than I could just one fighter.

I at least remember from those experiences—even if my memory is a little hazy about the last time I was a competitor—that when you are going to throw three blows in succession, that you lead off with a straight left jab—the purpose of that is to get your opponent off balance, "set him up" as they say in the vernacular of the ring—after which you follow with a right cross and a left hook in quick succession.

Therefore, as I read the announcement of this afternoon's talks, my purpose is to "set you up" for what is to follow. This seems quite proper, since *what* I have to say must fall within security regulations. This form of security safeguard of what we say in our public utterances follows Marquis of Queens-

berry Rules in that it insures that you protect yourself at all times.

I was subsequently informed that the overall subject for the Seminar this afternoon is "How Best to Mobilize our Chemical Assets for Defense."

As I see it, our "Chemical Assets" include science, productive capacity, and the capabilities of the using military services on land, on sea and in the air. As I will be followed by a noted scientist and a well-known industrialist, I will confine my remarks to how best to mobilize the military effort in the Chemical field for defense under the general title of "flexibility in planning."

Obviously this is not the place to discuss military mobilization plans per se. However, some of the factors which must be considered in formulating such plans may be of interest to all of us. For one thing, the production of CBR weapons favors a highly industrialized country. Our country is "Mr. Industrialist." Therefore, if an enemy resorts to toxic warfare and if we should ever use these weapons sufficient military means should be mobilized to take advantage of this great industrial capacity and to make it decisive. On the other hand, if toxic agents are not used, as was the case in World War II, a large block of manpower equipped and trained only to serve toxic weapons, might better be used for a different purpose. Therefore, our military means must be flexible in order to be effective in either case. This is not a great problem in the case of the Air Force, the Navy, or the Artillery of the Army. It means only that sufficient toxic bombs and shells must be developed, tested and proven and kept in war reserve with a procurement base so established that it can be readily expanded to furnish the requirements for repeated retaliatory attacks before the war reserve is used up.

However, special units equipped and trained for the purpose, can be more effective in some cases than can units which employ toxic agent filled munitions adapted to their weapons instead of the weapon being tailored to the agent. Toxic warfare employs practically all of the weapons that appear on the modern battle-field—grenades, mortars, artillery, mines, bombs, spray tanks, and other organic weapons of the Army, Navy, and Air Force. Therefore, the Armed Forces of the United States have a built-in capability for retaliatory use of toxics. It was demonstrated in World War I, however, as I have already stated and wish to repeat for emphasis, that extensive use of toxic warfare operations also require the employment of special techniques that cannot readily be achieved by conventional military units.

These special units, such as chemical troops for ground combat, present more of a problem. Of course, in World War I this problem did not exist as the use of gas had been initiated and was being used in ever mounting quantities before we entered that war. Therefore, it was only a case of mobilizing a force commensurate with the expected results, and one that we could logistically support. However, in World War II this did pose a problem. Toxic agents, though not used, were a threat and remained so throughout the period. In a way, the Chemical Corps can say that its efforts since World War I have achieved the ultimate in military success, since toxic warfare was prevented in accordance with the wishes of our own government and of our allies in World War II. Our vast availability of supplies and efficient preparations to meet any such attack has had a deterring effect when our enemies have considered the use of gas against us. But so long as wars continue to be fought periodically, the characteristics of toxic warfare which is derived from its capability to strike targets which cannot be reached by other means and to disrupt operations without material damage, will always be given serious consideration by one side or the other in a prolonged conflict. Its availability as a weapon to either side will always be a factor to be considered in defensive and offensive planning.

The problem of how to keep specially-trained chemical troops gainfully employed in a non-toxic war was solved in the last war by adapting a high explosive round to a weapon that was designed primarily as a non-persistent gas weapon—the 4.2-inch chemical mortar. With those adapted rounds, our chemical battalions actually added to the military effort during the years 1943 to 1945 in support of the infantry, and since toxic munitions were stocked in the theaters, gave the theater commanders the capability of retaliating against toxic warfare with battle trained, experienced units. This was a plan conceived by our illustrious wartime Chief —Major General William N. Porter. The soundness of this plan is attested by the fact that the 4.2-inch chemical mortar, after the war, was adopted as a standard infantry weapon. The 4.2 mortar has become obsolescent as a chemical weapon even though it still is superior as an infantry support weapon, and so the Chemical Corps does not feel handicapped by its recent transfer to infantry units.

However, in the development of new weapons, and the organization and training of modern weapons battalions, the flexibility of the units must be preserved. We must have the most modern and most efficient weapons in our field that science can develop. These weapons must be capable of being adapted for a useful purpose on the battlefield in case toxics are not employed, in order to make full use of all available manpower and the weapons which have taken some of our industrial capacity to produce.

When we consider the mobilization of military strength, the scientist and the industrialist frequently think of the excellence and the numbers of the guns. The soldier also thinks of the excellence and numbers of his guns, but he also thinks about the man behind the gun. I want to say a few words about the man behind the gun, or to be more exact—the leader of the man behind the gun. The conduct of modern war is becoming increasingly more technical. This is true on the battlefield as well as in the laboratory and production plant. And this will be particularly true in units employing our weapons. In turn, leadership is requiring more and more specialized and technical thinking.

To meet this requirement, the Navy and Air Force are training high calibre officers. The Navy keeps a continuous stream of student officers going through our Chemical Corps School. The Air Force keeps a sizeable number of officers on duty at Chemical Corps installations for extended periods, as running-mates of Chemical Corps officers so that they can familiarize themselves with CBR warfare. Some of these officers may find themselves in the logistical field in case of war, but many undoubtedly will be in command and staff positions in the fleet and at advance air bases. In the same way we in the Chemical Corps must plan to assign some of our best officers to field units.

To take a concrete example, one of the technical specialties of toxic warfare is micrometeorology. The meteorologists' duties are to predict the behavior and travel of gas, and aerosol clouds on the target. His calculations also influence the computation of ammunition requirements. If he makes a wrong prediction or calculation on the proving ground, *at worst* a relatively few rounds may be partially wasted. On the battlefield, a poor prediction, *at best* may cause the toxic attack to be ineffectual, and *at worst* may cause the death of many men since the target may not be neutralized as planned by the commander, or by the cloud actually drifting on friendly

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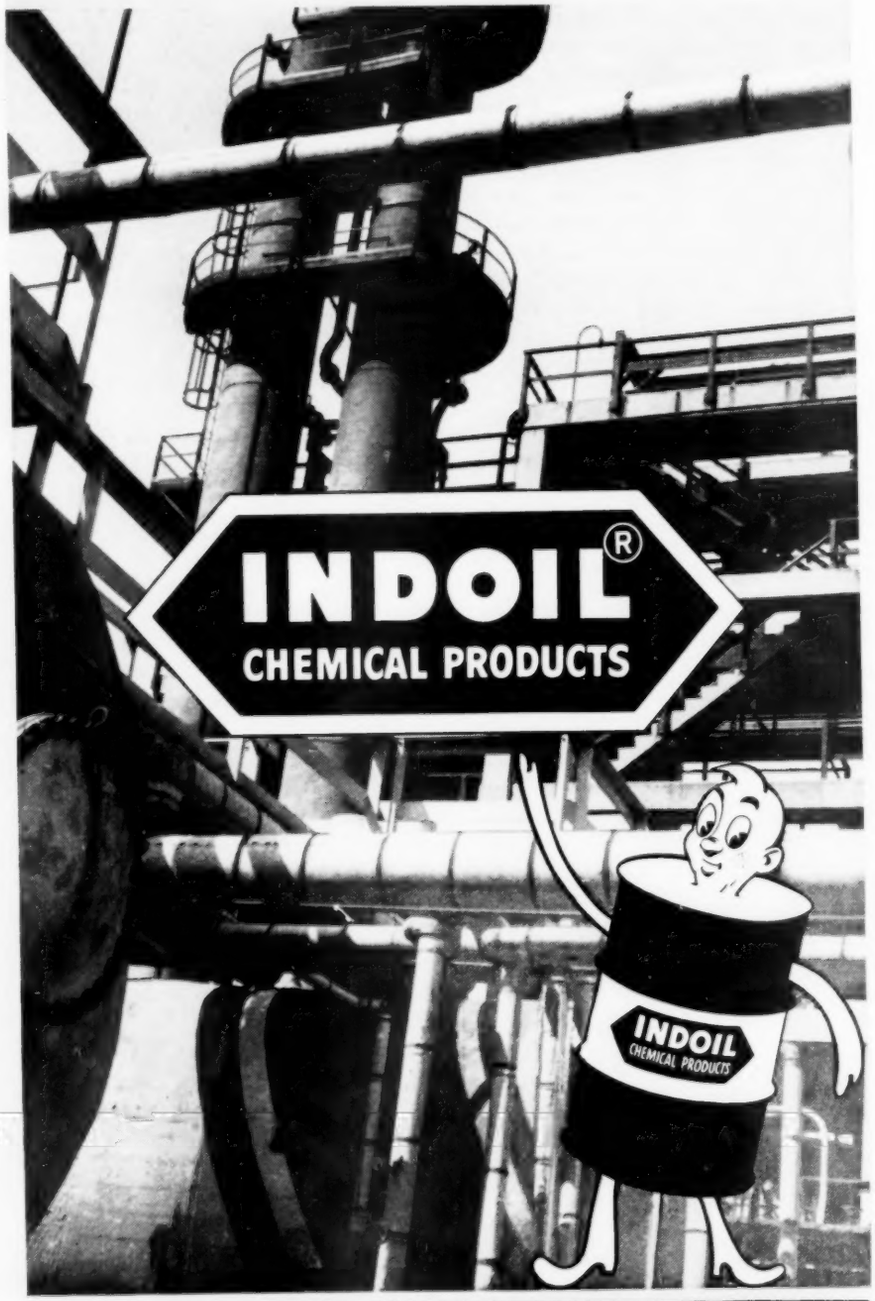

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troops. Such a mistake could jeopardize the success of an operation.

It has been long recognized that the military commander should be educated basically along engineering lines. This is evidenced by the Bachelor of Science degrees awarded by the U. S. Military Academy and U. S. Naval Academy which, in civilian colleges and universities, would nearest approach degrees in civil engineering and mechanical engineering. The engineer in addition to his technical background is trained to be a planner, and to have a feeling of urgency. Otherwise there would not be many roads, production plants, or production schedules finished on time. It takes considerable planning and a feeling of urgency for a commander to move his unit from here to there on the battlefield, accomplish his reconnaissance, and mount his attack on a tight time schedule. Therefore, the planning for how best to mobilize the military effort in the chemical field for defense, must include the users' proper share of technically trained officers for command and staff duties in combat units.

Last Saturday we celebrated Armed Forces Day. The observance theme was "Power for Peace." Here, today, we have a good cross-section of the foundation for that power. We have representatives of the team of three—the man of science, the industrialist, and the military man. Each represents a vital segment of our national assets required for the power necessary to preserve peace.

Daily the chemical industry is setting new record production levels, ending shortages, adding new products, and, in general, experiencing a vast physical growth. By using the know-how of the older heads, and the enthusiasm and ingenuity of the recent college graduates, the industry is finding new uses for old products and is continually adding new products for the use of industry as a whole—a form of flexibility in itself. Charles Munson, president of the Manufacturing Chemists Association recently said, "The chemical industry has no where to go, but up." And, as industry advances, so will the materiel it provides the military—quality-wise and quantity-wise.

In performing our part on the team of three, the military services in the chemical field must mobilize men and equipment which are not only the best found on any battle field, but are flexible in training and design for over-powering use under any conditions national policy may dictate.

WINNERS OF AFCA AWARDS TO OUTSTANDING ROTC STUDENTS

GEORGE R. CURRY
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University of Michigan
Ann Arbor, Michigan

RONALD DARBY
NROTC
Rice Institute
Houston, Texas

THOMAS R. DiDONATO
ROTC
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JAMES L. DORMAN
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Idaho State College
Pocatello, Idaho

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Vanderbilt University
Nashville, Tennessee

EDDY RA HAIR
ROTC
Mass. Inst. of Tech.
Cambridge, Massachusetts

CHARD ERLE HARKINS
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University of Okla.
Norman, Oklahoma

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Canisius College
Buffalo, New York

RONALD FRANKLIN LEHR
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HENRY ERNEST MEURER, JR.
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IDE P. TROTTER, JR.
ROTC
Agri. & Mechanical College
College Station, Texas

ANTHONY W. WARDELL
NROTC
Georgia Inst. of Tech.
Atlanta, Georgia

The following named men, whose pictures were not available at the JOURNAL press time, were also the recipients of AFCA Awards:

RICHARD BALZHISER
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Ann Arbor, Michigan

EMMETT K. BURK
AFROTC
University of Missouri
Columbia, Missouri

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Mississippi State College
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Iowa State College
Ames, Iowa

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Duquesne University
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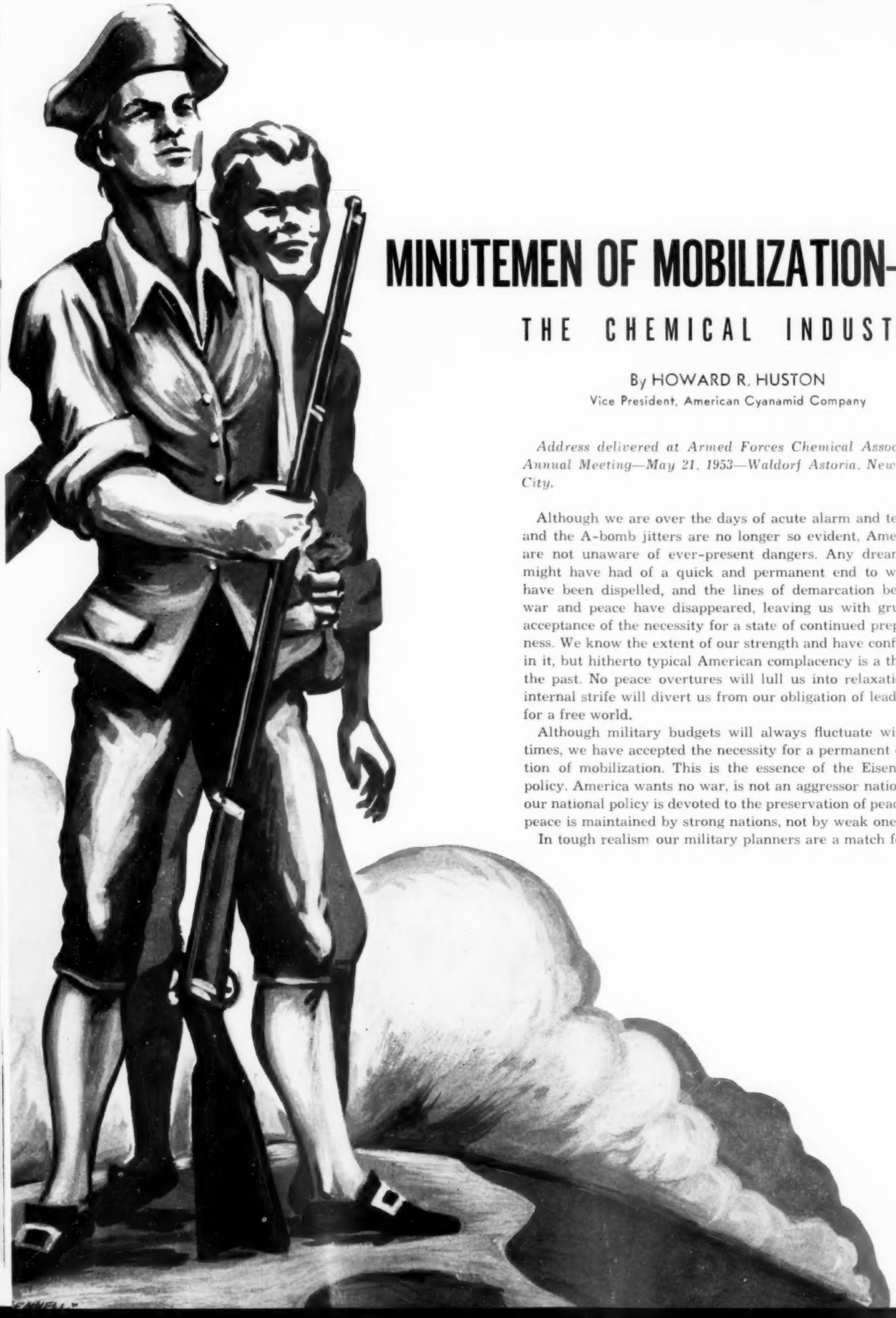
AFROTC
Rutgers University
New Brunswick, New Jersey

ANTHONY TURANO, JR.
AFROTC
Massachusetts Institute of Technology
Cambridge, Massachusetts



MINUTEMEN OF MOBILIZATION—

THE CHEMICAL INDUSTRY

By HOWARD R. HUSTON
Vice President, American Cyanamid Company

Address delivered at Armed Forces Chemical Association Annual Meeting—May 21, 1953—Waldorf Astoria, New York City.

Although we are over the days of acute alarm and tension, and the A-bomb jitters are no longer so evident, Americans are not unaware of ever-present dangers. Any dreams we might have had of a quick and permanent end to warfare have been dispelled, and the lines of demarcation between war and peace have disappeared, leaving us with grudging acceptance of the necessity for a state of continued preparedness. We know the extent of our strength and have confidence in it, but hitherto typical American complacency is a thing of the past. No peace overtures will lull us into relaxation, no internal strife will divert us from our obligation of leadership for a free world.

Although military budgets will always fluctuate with the times, we have accepted the necessity for a permanent condition of mobilization. This is the essence of the Eisenhower policy. America wants no war, is not an aggressor nation, and our national policy is devoted to the preservation of peace. But peace is maintained by strong nations, not by weak ones.

In tough realism our military planners are a match for any

potential enemy. Faced with a resourceful opponent, we know that any relaxation on our part is an invitation to aggression, and we can only keep the uneasy peace by vigilance and technological advances. The long-term view is basic to holding the advantage. A good case can be made for the belief that our superiority in atomic weapons has been the chief deterrent to further Russian expansion in Europe and the Near East, and so our research to harness all forms of atomic energy, a program in which chemical companies are playing an important part, continues to have highest priority.

The national budget is not yet in balance, but it is clear from the events of the last two years that we can maintain a military establishment of a size and caliber necessary to ward off attack and at the same time continue the production of civilian goods and further increase the American standard of living. However, we must also be prepared at any moment to switch from instant readiness to total mobilization, and our plans for such a transition must be carefully thought out and fully understood by all concerned.

Mobilization Defined

Dr. Vannevar Bush has pointed out that in any future all-out conflict we could not hope to match the forces in manpower that might be arrayed against us; it is obvious that in any nose-count we would be far outnumbered. "We can prevail," Dr. Bush warns, "only by a superiority in the use of weapons of defense and offense that will multiply the effectiveness of our manpower beyond anything an enemy can achieve."

Perpetual mobilization is a condition that is new to our economy. It is long-range rather than short-term. It involves maintenance of an advancing technology without extravagant expenditures for rapidly outmoded weapons. It means continuing production of goods essential to a healthy economy and an advancing standard of living, and at the same time, an awareness of the military potential of each new peacetime development.

The foundations of our peacetime progress have been our success in maintaining a superior technology and the managerial talents and skills to use that technology for the production of more and better things than any nation in the world has ever enjoyed. Our formula has been to produce in great quantity whatever a situation demands, and we should not find it difficult to extend its application to meet our present condition. Mobilization, be it partial or total, is a matter of planning, and it entails the same type of study which has characterized chemical industry market surveys, research, development and distribution. Just as the chemical industry today makes careful studies of the availability and economies of natural gas or coal 20 years hence—so must our mobilization plans be long-range and cover in detail all possible contingencies or possibilities.

For mobilization in the present day sense, we can count the virility of the American Chemical Industry one of our strongest bulwarks of defense.

To a greater extent than in other industries, chemical makers are the minutemen of mobilization. It takes only the time of a telephone call to divert a tank of styrene from a novelty comb manufacturer to a synthetic rubber plant. The same is true for hundreds of basic chemicals and important intermediates. Because chemical facilities cannot be created overnight, and yet these products are critical for all industry, a vigorous chemical industry with ample productive capacity must be reckoned as a resource of first importance.

Mobilization of the chemical industry must take into consideration several special factors. These include:

1. Chemical products can be switched instantly from one end use to another, but the industry must be ready now with the technology and productive capacity to supply the chemicals that will be needed later if other industries convert from peacetime to military products.

HOWARD R. HUSTON
Vice President, American Cyanamid Co.

2. We know that an all out war would call on us to deliver as much as three times the enormous volume of chemicals produced in even this peak year.

3. Because costly research and replacement of obsolescent plants and processes are the lifeblood of a healthy chemical industry, we must see to it that a climate favorable for continued growth is provided.

4. The essential role the industry plays in our country's defense must be broadcast to all elements of American society in order that the impact of the chemical industry be fully understood.

What are our chemical assets today? Has the industry kept up with the rest of American industry? How are its products used in mobilization? Is it prepared for the tremendous additional tasks it may be called upon to fulfill if total mobilization becomes necessary? What dangers threaten its continued growth? Will trained technical personnel be available when they are needed? These are the questions which must be answered in any discussion of how best to mobilize the chemical industry for defense.

Our Chemical Assets

Our basic chemical assets can be grouped under six general headings:

1. The great body of knowledge and skills the industry has assembled.
2. Chemical research.
3. Managerial experience.
4. The extent and condition of our plants and facilities.
5. The industry's technical service and knowledge of the operations of all industries which it supplies.
6. The growing public appreciation of chemical products.

Some idea of the extent of our heritage of chemical knowledge and the private, university, industrial and government research which is continually adding to it can be obtained from glancing at the programs of the twice yearly meetings of the American Chemical Society. Just to abstract all published research in 1950 required 10 million words, more than 8,000 pages of "Chemical Abstracts." The vast area of technical literature has expanded so rapidly that the number of journals of all types regularly surveyed by "Chemical Abstracts" jumped from 2,808 in 1936 to 5,300 in 1950. To a great extent other countries throughout the world also share in and

can avail themselves of this knowledge. There are now published in the world some 50,000 scientific periodicals containing approximately a million articles a year.

While we do not have a corner on this fund of knowledge, we have a unique advantage in that we know better than the industrialists of any other country how to put it to work most effectively. The principles of the diesel engine, cellophane and rayon were worked out abroad. It took American productive genius to improve on the basic idea and make it in quantity at the right price for the benefit of all the people. In that hard-to-define grouping which we call executive management, we have one of our greatest assets. Our planners and strategists on the industrial front are as skilled in executive and administrative functions as our renowned military commanders are superior to their counterparts in other nations. When we speak of the achievements of American industry, we must pay tribute to those almost anonymous managers and directors of large and small enterprises. Industry, which depends for its very lifeblood on a continuing supply of trained managers, is now and will continue to be even more so the bulwark of our defense.

Former President Truman said rather succinctly in his message to Congress in January, 1952: "During the last decade we have seen how basic scientific research can alter the foundations of world power. We have seen that this research yields a stream of new knowledge which fortifies our economic welfare as well as our national strength. We have learned that a strong study and wide range of effort in science is as essential to our sustained national security as the production of weapons and training of military personnel."

Nowhere do we have a better example of the contributions of modern technology than in the chemical industry. We have built a smooth functioning combination of the elements on which our prosperity and safety depend. The first asset, superb research teams — never satisfied with the best, continually probing and searching along every frontier of biological and chemical science for better methods, improved products and new uses for the limitless compounds that we have learned to synthesize—are increasingly doing basic research, studies aimed at finding out more about the fundamental behavior of animate and inanimate worlds without regard to immediate commercial objectives.

Our real growth has come about through the products of research. During the last ten years, new chemical products have been introduced at the rate of about one a day. The extent to which management has authorized expenditures for research has been a measure of this growth and progress. From 4,000 professional researchers in 1927, there has been a steady annual increase. Exact current figures are not available, but at least 30,000 scientists and supporting workers are employed in chemical industry research labs today, and upwards of $250 million a year is spent for investigative programs and development. Even though the industry is engaged in a multitude of problems relating to national defense, only about 7% of this research is federally financed.

Another asset is the executive talent, long on experience and performance, that the chemical industry has assembled in its rapid rise to the ranks of a major manufacturing industry. Our skill in managing and organizing research is responsible for the fact that fully 40% of the chemical industry sales are accounted for by products that were not known 15 years ago. This is a continual process—a type of mobilization that is very much like the type we are adopting throughout the economy. It takes advance planning, and careful appraisal of all elements, the financial in particular, to bring about a successful new chemical. Most of them average 7 to 10 years in development. Such a time schedule calls for constant evaluation of trends and a familiarity with all segments of the economy. Raw material surveys, projected as far ahead as 25 years, are a vital part of successful commercial chemical development. They are equally important for maintaining our mobilization for defense.

Since 1939, the chemical industry has increased fourfold, by U. S. Department of Commerce yardsticks. Using the Federal Reserve Board's adjusted index of production, chemicals and allied products have experienced a real growth of 390%, compared to the general industrial average of 190%. By other indices going back to 1925, chemicals have grown at the rate of 10% a year, compared to an average of 3% for all manufacturing.

The condition of our plants and equipment is a further asset in any mobilization for defense. Investment in chemical facilities has risen from about $4 billion in 1939 to more than $10 billion today. Our highly instrumentalized, almost automatic plants in all parts of the country are responsible for low-unit cost production and contribute to the performance of chemicals in increasing less in price during the last ten years than any other major commodity. Following a gigantic increase in capacity to meet World War II demands, the industry embarked on expansion programs costing more than $5 billion between 1945 and the outbreak of the Korean war. We are now about 80% through a further increase in plant expansion which by 1955 will add one-third to our 1950 productive capacity at a cost of $6 billion. About 70% of this expansion is related directly to defense, and has been granted Certificates of Necessity permitting five-year amortization. This gigantic network of modern plants and equipment places the American chemical industry far above that of any other nation in the world.

That respected military analyst Hanson W. Baldwin, writing in the New York Times of June 11, 1945, expressed it this way: "The industrial strength of America has been the dominating and decisive factor in this War (World War II) . . . This comment is far more applicable to World War II than World War I, and it will be even more applicable in the future. If any one element can be said to have decided this war, it was American industry; this writer feels the war would have been lost had that industry failed in the tremendous demands put upon it . . ."

Because the chemical industry supplies every other industry in America with its products, and because its livelihood depends upon keeping abreast of the requirements of these industries, it has an enormous pool of knowledge concerning the operations of all manufacturing. The chemical industry has started many other industries by developing new products which are translated into new applications. A large proportion of the research and development costs of chemical manufacturers goes for technical service, where the customers' problems are solved, special formulations are worked out and field men learn the intimate details of the customers' plant so that they may provide better service. This technical service and knowledge is another vital chemical asset which would be invaluable in a time of total mobilization.

One of the significant developments in mobilization of the chemical industry which has been particularly noticeable since the Korean War began is the close liaison which has been maintained between the Armed Forces, government, and leaders in the chemical industry. The industry has been generous in providing leaves of absence to its major executives, so that they may serve in such organizations as the National Production Authority in Washington. On the other hand, both the government and the Armed Services have maintained very close contact with industry by assigning personnel to major plants throughout the country. Perhaps the Armed Forces Chemical Association knows better than anyone else the sincere effort that is being made to maintain a continuous flow of information between the three parties concerned. I consider the excellent liaison that has been established one

of the outstanding chemical assets, and believe that its continuance is imperative.

How Chemicals are Used in Defense

Every product of the chemical industry goes to modern war in some respect. Some of its war products, like certain branches of the Armed Forces, work at the front. Just as each front-line fighter can function only if he is supported by rear echelon and service troops, so chemicals which are used in combat must be backed up by a vast network of products and services which the chemical industry supplies.

Modern warfare has a voracious appetite for explosives, which the chemical industry makes. The most dramatic development, of course, is the atomic weapons, but smokeless powder, the propellant, and TNT, the disruptant, have long been the mainstay of military explosives. Ammonium nitrate mixed with trinitrotoluene is the amatol of World War I. Ammonium picrate is an important shell-loading charge, much used for armor-piercing explosives. An important newer explosive is RDX, first used in World War II as a constituent of demolition, artillery shell, and bazooka charges. Torpex (a mixture of RDX, TNT and aluminum) is a highly effective underwater explosive.

Half a dozen other explosives and a couple score of mixtures and combinations are used for depth bombs, aerial bombs, incendiaries, trench mortars, rockets, rocket propellants, and flares. All demand products of the chemical industry in large quantities.

One company found that more of its explosives, even in wartime, were used for constructive purposes—road building, mining, land-clearing — than were hurled against the enemy.

Yet production of explosives accounts for only a small percentage of the direct defense items which the industry supplies. During World War II, a ranking American chemical concern, operating a number of Government plants, turned out the largest quantity of munitions ever manufactured by one company. Yet this volume amounted to less than 25 percent of that company's total wartime production in both its own plants and plants which it operated for the Government. The remainder was made up of hundreds of different chemical products for military or essential civilian uses.

The thousands of commercial products of the chemical industry have a wide variety of defense functions. It has been estimated that 200 different chemicals are required to outfit an infantry platoon; 1500 individual chemicals to launch a battleship.

Nylon yarn and staple go into military apparel, parachutes, tire cord for planes. Nylon molding powder is used as a tough jacketing on Signal Corps field wire. Tetrafluoroethylene resin insulates wire exposed to high temperatures. Polyethylene molding powder is used for the primary insulation on field wire. Trichloroethylene degreases metals.

Melamine resins turn up in Army dinnerware, map papers, shotgun shells, textbooks, containers. Textile resins improve military jackets, shirts, sleeping bag liners. Glass fiber insulates aircraft, tanks, ships, motor and generator windings. It also strengthens laminated plastics in aircraft construction.

Acrylic plastics are extensively used in aircraft cockpits, sighting domes, gun turrets; cast in prisms for tank periscopes; in sheet form for radar plotting boards and glazing in prefabricated military buildings.

The chemical industry supplies cordite, dynamite, nitroglycerine, sulfa drugs and other pharmaceuticals, varnishes and finishes for helmets, tanks, caskets and shells.

Polyester resins are incorporated in glass-reinforced plastics, which have as many as 80 uses in the F-86 jet plane. Army engineers use plastics for pontoons, footbridges, pipelines, and prefabricated housing. The Navy uses them for landing boats and other small craft.

An incomplete survey revealed 86 different chemical products from a single plant going into a B-29 Superfortress. One chemical company counted 325 different military items which required its plastics.

Just a few of the thousands of available examples convey some idea of the importance of chemicals in time of national emergency:

During World War II, vast quantities of traditional and new explosives were delivered by chemical companies operating their own and government plants, but even this record volume accounted for less than 25% of total chemical production. The Chemical Corps alone during the war purchased a billion pounds of 300 different chemicals, exclusive of those in the heavy tonnage or explosives field.

A billion dollar synthetic rubber industry hit volume production just 18 months after starting from scratch, as chemical companies turned out butadiene and styrene from test-tube to tank-car volume in record time.

Equally dramatic expansion occurred in plastics manufacture as synthetic materials took the place of short-supply metals and other materials. World War II planes required 200 plastic applications, battleships 1,000.

Production of tailor-made fuels skyrocketed more than 100-fold.

Increase in production of sulfa drugs and such medicinals as Aureomycin and Terramycin, have made outstanding contributions in reducing infection from wounds.

Working with government and universities, the chemical industry expended $25 million on penicillin research and development. The venture paid off and shattered all records for speed of production. By war's end 20 companies were producing enough so that it quickly became available for civilian needs. Chemical companies helped in the program of processing half a million pints of blood a month for plasma and other valuable components.

In the present fighting in Korea, the armed forces today are better clothed and fed, and have improved equipment and superior medical care because of the chemical industry's products.

For example:

A new lighter, tougher helmet made of an aluminum shell and a shock-resistant plastic liner is replacing the Army's old steel helmet with its thin plastic liner.

A new type of armored jacket of laminated nylon covered with a waterproof outer shell stops low-velocity shell fragments. Troops in Korea are also getting other nylon armor garments.

An improved field communication wire combines the substantial talking range and other characteristics of standard field wire with the reduced size and easy carrying of assault wire used by fast-moving troops. It is insulated with polyethylene, has a nylon plastic covering.

A disc-shaped container made of synthetic rubber is now being used for aerial free-fall delivery of gasoline, water or other liquids to troops. No parachute is needed to check its fall.

A new greaseless pack for rifles, machine guns and other small arms, has replaced the heavy grease coatings used in the past.

Plastic piping is being used in Navy minesweepers now under construction. It saves copper and nickel, until now used extensively in shipboard piping.

New chemical formulae used in napalm bombs have produced one of the most effective weapons of the Korean War.

While the direct defense functions of the chemical industry are highly important, the less dramatic but very important indirect assistance in the form of chemicals needed for the operation of every one of our 72 industrial groups deserves to be better known.

Whatever product you pick up in a quartermaster depot — paper, rubber, medicines, metal or fabric—has been processed and made to meet military specifications by the use of chemicals.

What Elements Could Do Us Harm

The already tremendous capacity of the chemical industry has caused some

people to be concerned. Will it be held back in its necessary growth because markets for its products become saturated?

The reaction of the stock market to recent "peacefeelers" fed some of the fears that have been circulating. A temporary leveling off in corporate sales of chemicals and allied products and slack demand in textiles last year has led to some retrenchment. I don't believe the over-production is serious, nor that the chemical industry has reached a plateau. Our experience after World War II and the fact that chemical companies' sales have always overshot the most optimistic long-term forecasts are favorable indications. The present diversified nature of the industry, and its history of constantly broadening its markets are factors which augur even broader usefulness for chemicals and chemical products.

Forecasters of reputation believe that in the next ten years the chemical industry will grow four to five times faster than the rest of industry. Silicone plastics, which have so many distinctly military applications, will increase seven-fold during the five-year period 1950-1955; polyethylene is slated for a considerable increase; new chemical man-made fibers will carve out in the next twenty-five years a share of the total textile market approximating the volume of the centuries-old materials, cotton and wool, we have reason to believe.

Ten years ago there wasn't a single entry on any chemical company's books for antibiotics. Last year, retail sales were $650,000,000, an impressive figure in any industry's assets and an even more impressive figure in terms of prolonging life and alleviating human misery.

It's going to take more selling, more technical service and more of the venturesome spirit that has characterized the chemical industry to keep our forward motion.

Groundless fears will soon be dissipated, but there are several other elements which cause us some justifiable concern: the general climate in which business operates, particularly the tax philosophy; arguments which would strip from the chemical industry the tariff protection it needs, a growing shortage of technical manpower, and the necessity for greater public appreciation of the industry's essential role.

Industry Needs A Favorable Climate

A great deal has been said about the necessity to preserve incentive and I think we all recognize that the effect of long-continued so-called "excess profits" taxes is to destroy incentive. When in the name of confiscating profits from wartime sales growth companies have to pay as much as 82% of their profits, bringing along new products is scarcely worth the effort. Many chemical companies have felt the full brunt of this tax and it has tended to discourage or postpone those endeavors which are an essential part of a dynamic economy. There will be no mourning in the chemical industry when excess profits taxes expire.

There is another characteristic of the chemical industry that deserves more understanding—our potential high rate of obsolescence. The amount of depreciation set-asides fails to meet the chemical industry's replacement requirements by some $4 or $5 billion a year. With taxes as they are, it is easy to see that retained earnings are not sufficient to pay for equipment replacements and have much left for new expansion.

Protection Necessary

As strong as the industry is today, it is not invulnerable. Before 1914, in the synthetic organic chemicals branch it was virtually non-existent. Because of encouragement from government and public through tariff protection it developed into a well-rounded and flourishing industry. Other countries both within and outside of the free world have similarly supported their chemical industries. The most important reason behind these programs has been for defense in time of war.

We recognize the desirability of international trade to raise standards of living among people in the free world. We are aware that "trade not aid" has obvious advantages, but we do have to be realistic about the effects of importing even a few basic chemicals in such amounts that domestic production would be dangerously weakened. Exclusive dependence on foreign sources of supply —because foreign costs are geared to a lower standard of living, not because our own industry is inefficient—could very well wreck our most careful plans. Aniline best illustrates the interlacing spread. Similar cases could be made out for phenol and phthalic anhydride—two other simple coal tar intermediates.

From aniline stem literally hundreds of more complex intermediates and finished products. Aniline is the starting material for 51 of the organic pigments and toners. It is a component of 145 basic, direct acid, sulfur, vat and oil-soluble dyes. It is also the starting point in the manufacture of accelerators and antioxidants indispensable to the processing of both natural and synthetic rubber.

The explosive tetryl is a derivative of aniline. Aniline goes into the manufacture of the whole series of sulfa drugs, including sulfanilamide, sulfapyridine, sulfathiazol, sulfaguanidine, sulfadiazine, sulfamethazine, and sulfamerazine. Phenothiazine, which has proved so effective against intestinal parasites in sheep, is also a derivative of aniline.

Derivatives of aniline may be found in the colored advertisements in magazines, in automobile tires and garden hose, on the shelves of retail stores, and in the medicine chest at home. Curtail the production of aniline and the entire defense program and civilian economy will be affected.

The same sort of pattern obtains with anthraquinone and its derivatives, with beta-naphthol and its derivatives. And their varied end uses are illustrative of the ramifications of scores of other chemical products.

A curtailment of a few basic chemicals would slow down the wheels of all industry. Industries of every description would be seriously crippled without the aid of the 7,000-odd products which the chemical industry produces to improve food, to safeguard health, to improve clothing, to hold down costs of transportation, and to multiply effective fire-power on the front line.

In its complex operations, which are most efficient when laws of supply and demand prevail freely, the chemical industry moves as a unit. Just as an infantry division advances along a front with all its supporting units of maintenance and supply, so chemical advances must cover every sector. You can't take some members of the team out of action, without making the whole unit vulnerable.

A realization of the delicately integrated nature of the industry will tend to lessen pressures for opening up our markets to synthetic organic chemical competition from abroad. Because the domestic industry must operate at 85% of capacity to make the profits out of which research and development are supported, a relaxation of tariff for just a few basic chemicals and intermediates would quickly weaken the whole structure.

Shortage of Technical Man Power

One situation which has been critical in recent years is maintaining the supply of technically trained graduates to staff the rapidly expanding chemical industry. In 1900 there were only a few hundred chemists in the United States. Today, there are more than 100,000. In the national area of research and development alone, about 130,000 scientists and engineers were employed during 1952 in some 3,500 industrial, institutional, and government laboratories. During the same year, our universities and colleges granted 93,437 technical degrees, excluding those in the field of

medicine. Still, it isn't enough. Only 86% as many chemists and chemical engineers finished college in 1951 as in 1950. This ratio dropped to 72% in 1952, and will be 64% this year. Also, industry will get a lower proportion of even this restricted number, as a large percentage is pledged to the military services as members of the Reserve Officers Training Corps.

The Need for Better Communications

As the chemical industry has become more complex and the population of the United States has grown, we have had a great problem in keeping in touch with each other. In spite of the number of information outlets, there are vast areas where communications have either broken down or there is a deplorable time-lag.

Industry knows how to produce, it is learning how to inform. Some have learned at great pain that they exist and prosper by public sufferance. After years in the dog house, business is getting over its stagefright and becoming more vocal. It recognizes its right and obligation as a good neighbor in the big American community to interpret its value and accomplishments, to defend itself against low blows, and to advocate policies under which it can thrive and benefit the entire economy.

Because the chemical industry has been so busy putting on muscle and growing at a prodigious rate in every direction since 1925, I am afraid chemical manufacturers have not given enough thought to public information. My friend Sid Kirkpatrick calls it the greatest story never told. In defense I can only say that explaining what the chemical industry is and how it operates is not as simple a task as other industries have. Even those of us who are able to keep abreast of our own companies' line of new products don't always understand all their applications. It's a staggering job to sift out the significant developments in such a fast moving industry and put them in understandable terms.

There is a great fog of ignorance and misunderstanding about chemicals which will take some time to dissipate. Unless it is, we face a very real threat to our further progress.

The average person seldom comes in contact with heavy chemicals, and unless we in the industry are well informed and see to it that the story is told of how chemicals of all kinds are playing a vital role in satisfying human needs, we cannot blame the man in the street for thinking about the chemical industry as a potentially dangerous place to work, a collection of profit-minded operators who are promoting artificial and dangerous substances in foods and drugs, and a polluter of air and streams. When it comes to materials of war a large part of the public has only a vague idea of the defense functions of chemicals aside from high explosives, smoke-screen gases and drugs.

It is even harder to get over the idea that many chemical processing plants are not convertible to products that may be more in demand with changing conditions, and an over-all expansion of chemical plants and facilities in time of emergency is imperative. Although most chemicals serve in both peace and war, defense frequently changes the ratio of demand.

Unlike the automobile industry which can shift its lathes and presses from passenger car manufacture to military vehicles, or a typewriter plant which can tool up quickly to produce ordnance parts, large numbers of chemical plants are relatively inflexible. To an extent production can sometimes be increased, but a sulfuric acid plant can make nothing else.

Thus, an expansion of its total plant is the only way the chemical industry can meet high defense requirements, not wholly separable from growing normal industrial needs, and provide reserve capacity for contingencies.

Within the last few years, however, the chemical industry has shown a disposition to realize that it must tell the story of its accomplishments, how it operates and how its products and processes have contributed importantly to raising the standard of living.

Early this month the Manufacturing Chemists' Association representing some 124 producers of chemicals and allied products published a 100-page collection of facts about the industry. This is the first time to my knowledge that we have attempted as an industry to forthrightly explain what the chemical industry does and why its continuing prosperity is vital to this country in war and peace. It is a story worth reading and telling.

Through similar information programs, the industry can accomplish a great deal in creating the type of climate in which it can operate most efficiently, and it can create sympathetic understanding of its need for protection against foreign competition.

A recognition on the part of the public and our government officials that the chemical industry is a basic national asset will create conditions under which the industry can go forward to develop to the fullest the teamwork which has produced the sulfa drugs, antibiotics, plastics, chemicals which improve the yield of crops of food and fiber, and assist every other industry to turn out increasingly better products at the right price for our ease, comfort, convenience, and, if need be, fight for the way of life we all enjoy.

To sum all this up—If we want our chemical industry ready for a national emergency, we don't have to convert it to any special wartime footing. A healthy peacetime chemical industry is always mobilized.

But it will not be healthy unless it exists in an economic environment free of restrictions, free of tax inequities, and free of the erratic competition of substandard prices from abroad. It must be up to date, it must have enough technically trained personnel, second to none, and, most important of all, the industry must be self sufficient and independent of any other nation in the world.

• • • • • • • PROFESSIONAL DIRECTORY • • • • • • •

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Enhancing Our Potential

By R. E. GIBSON
Director, Applied Physics Laboratory The Johns Hopkins University

We have come together this afternoon to consider "How best can we mobilize our chemical assets for defense." In this paper I want to discuss an asset which grows in importance year by year, namely, our ability to spring technical surprises on the enemy; our ability to devise new and superior devices to strengthen the hands of our fighting men, the ability which comes from the intelligent use of focussed thought and organized skill in forward looking research and development. May I introduce this subject by a few remarks outlining the position of research and development in the field covered by this symposium. In general terms, I think we can summarize our resources for defense in the following order of readiness.

First, there is the force in being, the manpower, weapons and equipment already mobilized for deployment.

Second, there is the reserve of trained men and the stockpile of weapons and equipment available for deployment.

Third, there is the immediate industrial capacity of the country for supplying larger quantities of standardized weapons and equipment.

Fourth, there is the industrial reserve that may be converted to war production.

Fifth is our reserve of manpower for combat operation and activities in direct support of combat operations.

Sixth, and supporting these, are the research, development and engineering organizations engaged primarily in the development of new weapons and equipment.

Seventh is the reserve of trained research and development men and the facilities in industry, private institutions and universities.

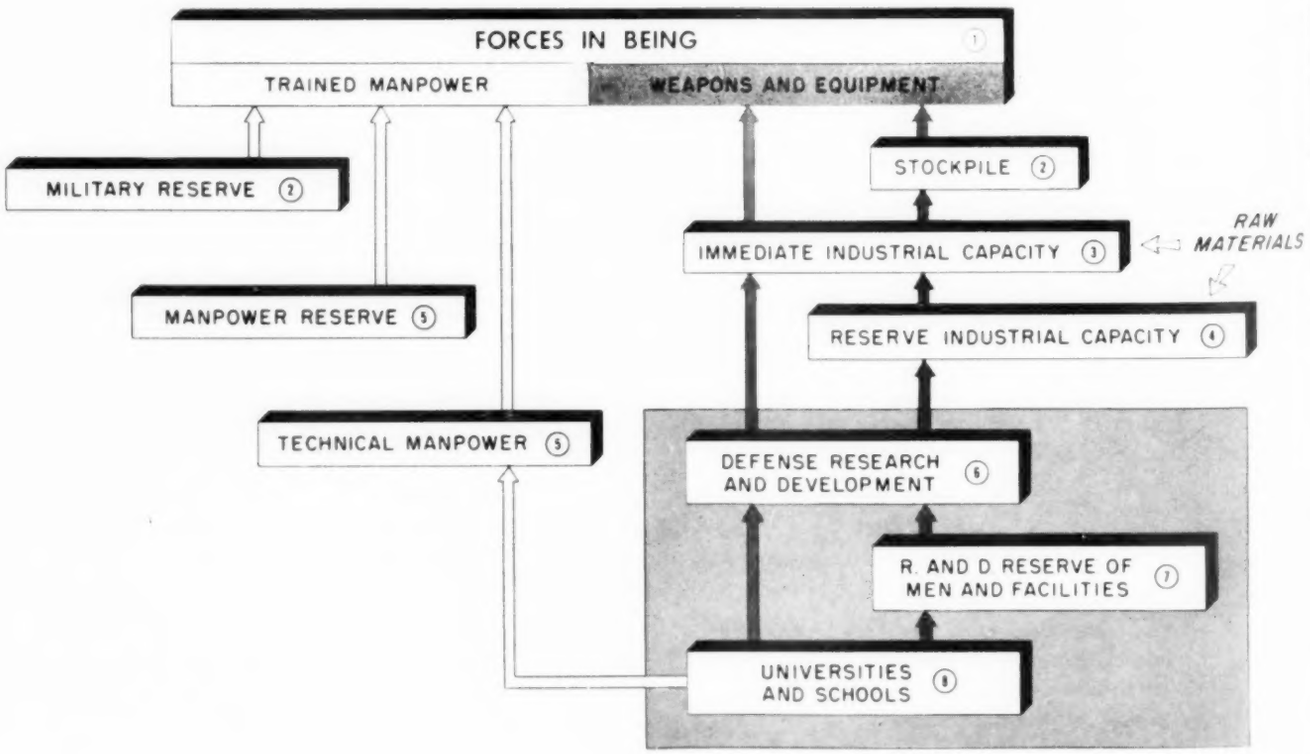
Eighth is the potential of universities and technical schools to keep an annual supply of trained leaders in all fields, especially those pertaining to research, development and engineering.

This paper is concerned with the sixth, seventh and eighth items which I shall class together under the general term, *our technical potential*. In this area, mobilization of our chemical resources presents the same general problems as the mobilization of any other scientific assets and I think we should do well to keep the whole scientific picture before us because of the proven value of the translation of technical and administrative ideas from one field of science or technology into another. I, therefore, invite you to consider some of the problems and their possible solutions involved in keeping a supply of up to date material assets for the support of our

*Address delivered at Armed Forces Chemical Association Annual Meeting, May 21, 1953, at the Waldorf Astoria, New York City.

(Figure 1)

RESOURCES FOR DEFENSE



armed forces. The maintenance of this support involves the output of men trained in science and engineering, creative men who can supply new ideas, critical men who can evaluate their validity, and skilled practical men who can reduce the ideas to tangible forms.

Basic Assumptions

At the outset, I should state explicitly some background assumptions that I take as self-evident and that underlie my thinking on the subject of our technical potentialities.

(1) The results of research and development can be regarded as actual defense assets only when they are translated into useful weapons, equipment or other tangible resources through the production engineering and production mechanisms of industry. This emphasizes the importance of the transition of items from development to production, linking all activities from basic research to production in the regenerative circuit of modern technology.

(2) The prime objective of technology in this field is to provide our armed services with tools to do military jobs, to solve strategic or tactical problems. In the previous section, I used the word "useful" weapons and equipment quite deliberately. Tools are not ends in themselves but means of doing jobs that would otherwise be impossible, or of doing possible jobs with much less expenditure of human effort. The responsibility of research and development is to see that technology provides the armed services with tools that give them the capacity to spring surprises and that enable them to do *tomorrow's* jobs with less expenditure of manpower. It may be noted that one average worker in American industry can turn out products at a rate that exceeds the output of five workers in potentially unfriendly countries. It is the responsibility of research and development to see that this differential is preserved on the field of battle.

A secondary objective of technology mobilized for defense is to provide alternative methods for producing goods needed in support of the civilian economy of the country while a large fraction of its capacity and raw materials are devoted to the direct support of military operations. For simplicity, I shall merely note this objective as important but not discuss it any further.

(3) Since weapons and equipment are essentially tools to help the armed services do military jobs, i.e. solve strategic and tactical problems, it is important that designers, developers and producers have a clear idea of what these military problems are. As in industry, the responsibility of the research director, the chief engineer or the production manager extends beyond the design or fabrication of a product ordered by a customer. He must assure himself that the product will actually fulfill all the requirements, foreseen or unforeseen, that are likely to arise when the customer actually uses the device to solve his particular problem or carry out his mission. The scientist or technologist has a unique contribution to make toward the initial decision to proceed with the development of a weapon or of an item of equipment, a contribution which arises from his knowledge of alternative technical ways of solving the same military problem and his ability to make an assessment of performance, based on a breakdown of the military problem into its technical components. Hence, we must keep in the back of our minds the complete circuit, research, development, engineering, military use and back to

DR. RALPH E. GIBSON

research. Experience has shown definitely that, when this procedure of initial and continuous technical assessment of the service value of end items is carried out by technical men, the chances of a project being cancelled before completion are much less.

(4) A weapon or item of equipment, if useful, forms part of a weapon system operated by men. Not only must "systems" thinking be fed back continuously into the research, development and production phases of the individual item, but the characteristics of the human operators must also be studied and fed into the picture. This is especially important in the present trend toward higher and higher speeds which call for extremely quick and sure decisions on the part of human beings. Development of training methods and adaptation of machines to the characteristics of unskilled or semi-skilled personnel is an important element of the circuit we are synthesizing.

(5) There are limitations on the technical manpower available for research, development and engineering in augmenting our resources for defense, and there is no reason to suspect that these limitations will ever leave us. Furthermore, when we take quality into account and consider the best men available for carrying a program through in an imaginative, efficient, speedy and thorough manner, we find that these limitations are very severe. In addition, a development, to be useful, must pass through the production stages where the costs of operations and facilities become very high, and we just cannot afford to make everything that seems desirable. It is, therefore, evident that to keep our technical potential at its maximum, intelligent discrimination must be used in choosing from many possible developments those most likely to give products that solve important military problems at reasonable cost and on a realistic time scale. Especially important is it that the minimum of good technical effort be expended in regions of diminishing returns. This intelligent discrimination cannot be exercised by officials sitting in offices or by intuitive guesses based on arbitrary criteria such as the presence or absence of duplication. It requires the most enlight-

ened, objective and critical approaches available for decision making. Fortunately, methods are continually being improved for objective analysis and evaluation of the cost of doing military or other jobs by different technical means. These methods, however, require for their application, teams of well trained men, highly endowed with common sense, well informed concerning military problems and thoroughly acquainted with the current state of science and art in the pertinent fields.

(6) While our present position in a struggle for supremacy or survival depends on present production capacity and the products now being made, our future position, our ability to keep ahead or gain in the race depends on our technical potential. Today's products may rapidly become obsolete and an army committed to yesterday's tools is in a sorry plight. The Battle of Britain was won by the Spitfires whose prototypes were on the drawing board or in the development shops while the Messerschmitts and other planes in the Luftwaffe were coming off the production line. In a rapidly moving art, like the design of aircraft, the newer development gives a tactical superiority which is almost impossible to overcome by greater numbers of inferior items.

Where this technical potential resides and how it may be augmented form the next part of my talk. In the meantime, I should like to summarize some consequences of the foregoing assumptions by a diagram. (Fig. 2)

This diagram illustrates the processes that should be followed in order to establish the definite and carefully chosen objectives upon which our creative technical resources must be focussed, if they are to be used intelligently. It emphasizes the analysis and assessment that must be made if the development program is to result in a system or item that enables the services to do a significant job with minimum expenditure of manpower or maximum value of some other payoff function. The realization of a military need for an item leads to formulation of desirable operating characteristics of the item, which in turn requires analysis in terms of current technical possibilities. This brings to light critical problems which may require reference to research and development for solution. A satisfactory solution, or possible solution, of the critical problems leads to a definition of the feasible technical characteristics of the item and an assessment of the advantages in terms of payoff functions, e.g. greater effectives at lower cost in dollars or overall manpower to be expected from the item. The results are then compared with the original desired characteristics and another excursion around the loop will proceed, this time with a clearer picture of possible reconciliations between what is desired and what is feasible. In some cases, it may lead to a reformulation of the original requirements. Out of the oscillations in these circuits are radiated a clear objective, a means for attaining it and a decision to proceed through the channels of research, development and production. This objective has behind it a realistic appraisal of technical possibilities and of the usefulness of the end item when it is produced. It forms a relatively sound basis for the commitment of effort.

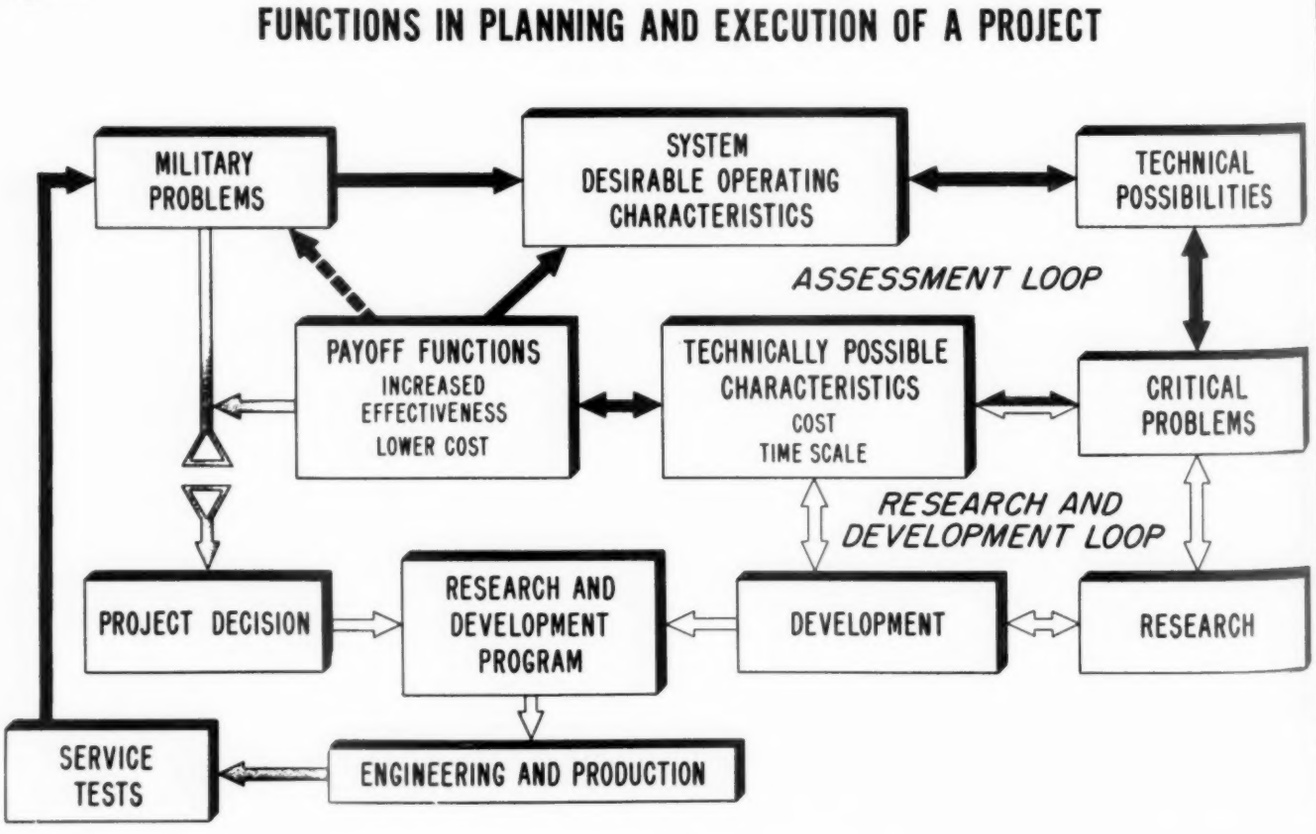
Augmenting our Technical Potential

As I understand it, the word "mobilize" connotes the bringing of a group or activity into a state that permits it to move rapidly in a definite direction at short notice. I should like to look at our technical potential to see where improvements may be instituted to facilitate rapidity and flexibility of action when emergencies arise.

The Useful Arts

From time immemorial, our technical potential has resided in the industrial arts, or as they are sometimes called, the "useful arts." These have been the sources of all the material benefits, commodities and tools on which we depend for comfort, welfare and security. The incentives of the "useful arts" lay in a realization of the needs or wants of society, of pos-

Figure 2

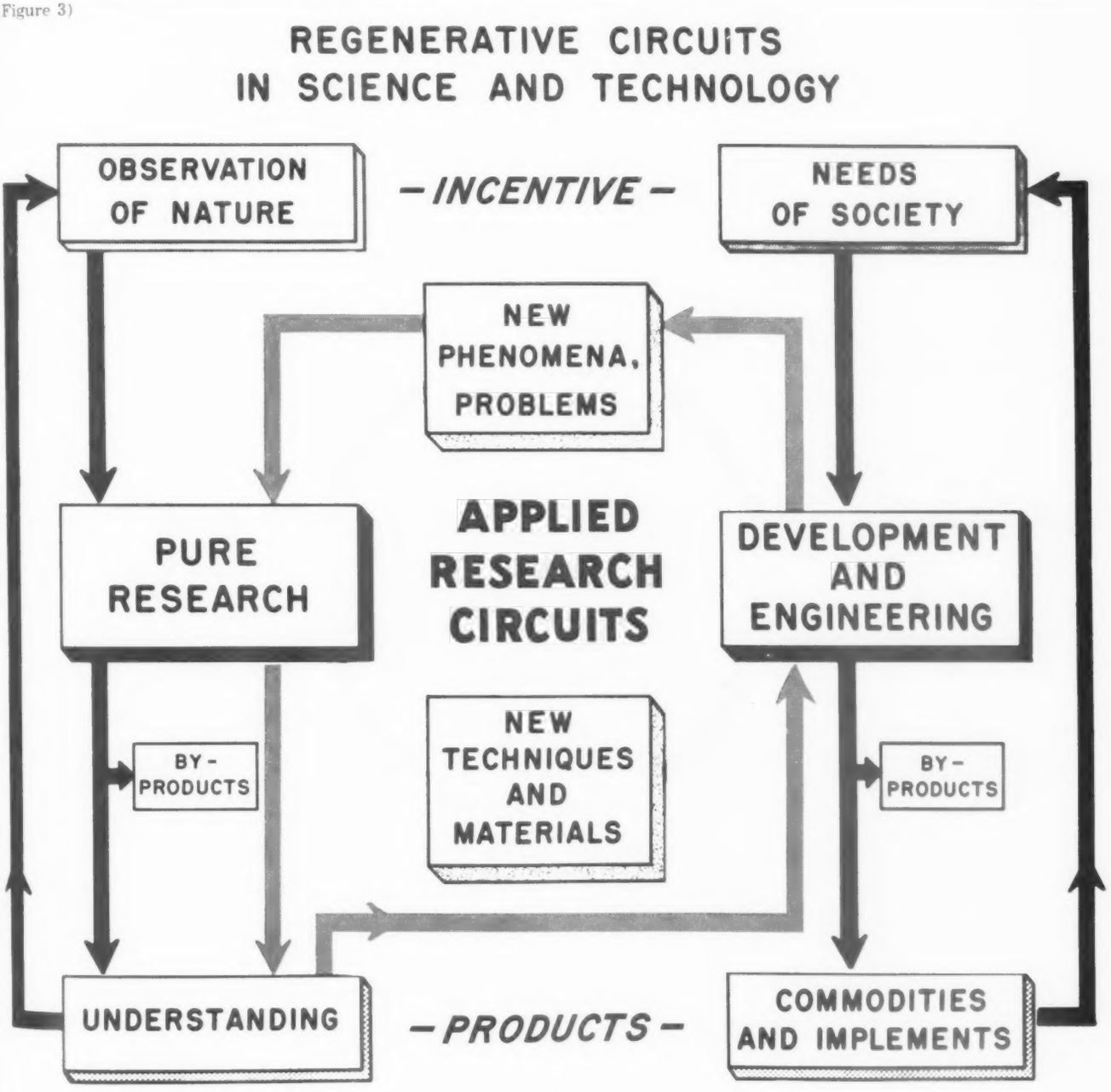


sible markets, and of military or economic problems. The methods used by artists and artisans were purely empirical based on individual training, ingenuity, skill or experience. The ability to perceive, weigh, and integrate intuitively many elements of a complex phenomenon and to express the results of this intuition in a tangible form is an essential trait of the successful artist. By these attributes, artists through the centuries have been able to reduce to readily apprehended or useful forms complexes of ideas they did not understand explicitly, by rules or practices learned by empirical or "cut and try" methods. The arts and industries were founded on complex rules and procedures of purely local or specific application which were often the result of years of patient and groping search. Frequently, these rules and procedures were so specific in their application that a slight departure from standard practice resulted in failure. It is not surprising that their "trade secrets" were one of the most highly valued possessions of each art or craft. Teamwork was not a characteristic of the arts. It can easily be realized that departures from standard practice were discouraged and the extension of an art or the creation of a new one depended on chance or on individual intuition. You will see, therefore, that while we might mobilize the useful arts to increase the production of established weapons and equipment, grave uncertainties arise if we depend on their empirical approaches for new and surprising tools of warfare. The combination of science with the useful arts has made a fundamental change in this situation.

Science

"Science" says C. N. Hinshelwood, "is not the mere collection of facts, which are infinitely numerous and mostly uninteresting, but the attempt of the human mind to order these facts into satisfying patterns." I subscribe without reservation to this statement which places as the *principal* objectives of science, the study of human experience, the establishment of the validity of this experience and the fitting of valid experiences into satisfying patterns or structures. The great contribution of Newton was not the observation that apples fall, but the fitting of this fact into the same pattern that describes the motion of the planets in their orbits. By combining his experiences as an architect with those as a chemist, Kekule's imagination created the theory of the structure of organic

(Figure 3)



compounds and developed the elements of a satisfying pattern into which the facts of organic chemistry have been fitted and which has been responsible to a large extent for the rapid growth of this science.

Thus, while the by-products of scientific research may be items of such importance as new instruments, new materials, new machines, the amassing of data or even the creation of new sciences such as electronics or nucleonics, its unique and principal objective is the *systematization of human experience*. It may be noted that a pattern is satisfying when it is simple both in its units or elementary designs and in the laws governing its extension in space. This attempt to fit valid experiences or "facts" into satisfying and self-consistent patterns is important from three points of view. In the first place, it facilitates *comprehension*. An established pattern is an excellent aid to memory; we can carry around a great deal of knowledge merely by remembering the pattern and not overburdening ourselves with isolated facts. This increases the power of the human mind to *comprehend* its cumulative experience; I need hardly remind you that such a pattern is exemplified by the laws of thermodynamics and the theory that makes possible rigorous deductions from them. This pattern embraces a large fraction of the experience of chemistry and engineering. In the second place, a pattern gives us a basis for *understanding* by bringing out relationships among isolated facts or events. We understand new experiences when we can express them in terms of experiences already familiar to us. In the third place, a satisfying pattern always suggests extensions of itself and, thereby, gives a sound and fertile foundation for the *prediction* of new facts or events. In short, a satisfying pattern (or theory) enables us to mobilize knowledge for immediate use not only in the fields of pure science but also in the fields of applied science.

Applied Science

About 100 years ago, science reached a stage where it could make significant contributions to the "useful arts" by providing for them a broader basis for understanding and consequently making predictions about the processes and products that are the business of the "useful arts." In other words, the "satisfying pattern" had been extended so far that it now began to accommodate the experiences already gained in the useful arts and to predict new possibilities for application in the production of commodities. The industrial uses of electricity and the application of organic chemistry to the manufacture of synthetic dyes ushered in an era characterized by the increasing use of the discipline and understanding of science to supplement the empirical knowledge and intuitive skill characteristic of the useful arts. This has resulted in an *acceleration* of the development of the new technologies on which modern life depends. Practical technologists have sought more and more to broaden the basis of their operations by drawing on the power of the "satisfying patterns of human experience" to predict promising directions for advancement of their arts and to cure troubles when they arise.

In Figure (3), I have attempted to illustrate some of the important relations of applied science by the use of closed, regenerative circuits, an analogy that has already been used. On the left side, we see a red* circuit involving pure research *—the step between curiosity and understanding.* Since understanding leads to keener, more intelligent and more powerful observations, a positive feed back exists in this circuit and ideas build up rapidly. The growth of schools of research and the tremendous increase in the size and number of scientific journals bears eloquent testimony to the effectiveness of this feed back. On the right, the "useful arts" are represented by their modern counterpart, development and engineering—the step leading from the awareness of a need or market to a commodity to supply the need. New products stimulate the desire for newer products and a positive feed back exists in this circuit also—a feed back fortified by competition and profit motives. In the military field, this positive feed back is particularly pronounced. The development of a new weapon of offense demands immediate advances in weapons of defense and vice-versa. We can expect the amplitude and frequency of oscillations in this circuit to build up at ever-increasing rates and the history of technological output of this country in the last twenty years is ample evidence of this build-up. In between the two extremes, represented by the red circuits, lies the region of *applied research*, the region in which most of our larger research institutions now operate. I have purposely refrained from representing "applied research" by a block with special incentives and objectives but have used, instead, two circuits to typify its functions.

The *blue arrow* indicates the demands of development and engineering for "understanding." In the course of a development, new phenomena may be encountered or problems arise which require elucidation from a broad point of view. These stimulate the interest of the scientist, if brought to his attention, and the understanding resulting from his researches feeds back to broaden the basis on which the development rests, to predict promising modifications or suggest remedies when trouble arises. The development of high performance jet engines furnishes an excellent example of the working of the blue circuit. These engines depend on combustion reactions in gases moving at relatively high speeds, and in the course of their development, many significant problems have been brought to light in chemical kinetics, fluid dynamics and thermodynamics—the need for a fundamental theory of flames has been accentuated. These problems have challenged the research physicists and chemists to develop understanding and already their results are being fed back into the design of practical engines.

The *green arrow* indicates a circuit energized by what are essentially by-products in the quest for understanding, new substances, techniques or principles. The outstanding example of this circuit is the use of atomic energy which applies on a large scale substances and techniques that were completely in the domain of pure research only a few years ago. Another current example is a by-product of solid state physics (one of the more academic subjects in modern physics), namely transistors. The green circuit has already started to oscillate in the transistor field and a revolution in electronics is in process.

Figure (3) presents a simplified and unified picture of science and technology, the modern source of our technical potential and suggests two points germane to our present discussion, namely (1), the intrinsic place of pure research as a necessity and not a luxury in the whole scheme of technology since it is the source of understanding—the catalyst of technological advances; and (2), the need for better communications between fundamental research and engineering if full use is to be made of this catalytic action so necessary when mobilization comes.

I have already enlarged on the first point and will merely add that satisfying patterns of facts or understanding are analogous to a base from which technical advances can be planned and made, and suggest that the proper time to build bases is before the emergency arises. We cannot feel that we are in a healthy position to mobilize our technical potential unless a significant fraction of the effort not only in university laboratories but also in the research organizations of the government and of industry is devoted to forward-looking fundamental research directed toward the theoretical development of the areas within the laboratory's competence.

Communications

In considering the second point, we note that the build-up of healthy oscillations in the green and blue circuits depends on the ease and certainty with which ideas circulate within

*Red indicated in diagrams by solid lines, blue by dark shaded, green by light shaded lines.

them. Portentious ideas may be generated or regenerated in either main block, pure research or engineering, and the transmission of ideas depends on the ease with which scientists and engineers can *communicate* with each other. Although conditions have improved enormously since 1940, the impedences in these circuits are still too high and the circuits themselves are "noisy," with the result that transmission of ideas is neither speedy nor certain. The remedy lies in a deliberate attempt to create teams of research scientists and engineers, of thinkers and doers, who speak a common language, who can communicate easily and certainly with one another. This problem could be attacked at the educational level, but schools of engineering and of scientific research have moved so far apart in their means of expression, concepts and standards that a major revolution is needed. It will probably come slowly as the demands from technology get more insistent. Another method is the establishment of organizations staffed with *some* men who understand both languages, appreciate the significance of the problems and methods characteristic of both blocks and who act as *catalysts* to promote the flow of ideas around the entire circuit. The development of ram jets at the Applied Physics Laboratory provides an example of what can be done in this type of catalytic activity by individuals who set out to express the engineering problems in terms understandable to theoretical chemists and the results of the chemist in terms whose significance could be readily apprehended by the engineer.

The most thorough-going solution to the impedence and noise problems in the applied research circuits is the establishment of good communications among all scientists and engineers in a composite organization so that ideas flow readily and are apprehended rapidly. Needless to say, this establishment of communications involves many personal and other problems which cannot be generalized, but I think there is one generalization that can be made, and this is based on the assumption that communications take place most rapidly and effectively in a group where all the members are imbued with a common point of view. Part of the delay in the engineering for production of a product from the research laboratory lies in the fact that the scientists do not appreciate certain points which are significant to the engineer and the engineers are unaware of points of great significance to the scientists. The common point of view which I suggest for a modern technological team is a thorough-going belief in the value of satisfying patterns of facts, in the value of fitting of facts into a consistent theory as opposed to the treating of facts or tests as isolated events or speculating on causes of trouble without any reference to theory and fact. With this thorough-going belief must also go a lively realization that our theoretical pattern is always incomplete. Science is growing constantly, our patterns are growing constantly and will never be perfect till we know and understand everything. We must recognize that any scientific or engineering undertaking has of necessity its groping, unpredictable, empirical phases; the point is to make the best and fullest use of the patterns of science where they can be applied, and then supplement them by skills of the arts.

As an illustration, consider a journey by car from this hotel in New York to the house of a friend in a new suburb of Los Angeles. If I have not travelled this way before, I shall be well advised to procure and study up-to-date road maps (satisfying patterns resulting from the analysis of the experience of other travellers.) These road maps will enable me to plan and carry out the journey to Los Angeles by the most expeditious routes. However, when I get in the vicinity of the new suburb, I may have to do some empirical hunting by consulting gas station attendants or policemen. I may take some wrong turns in my ignorance and finally reach my destination by "cut and try" methods. I shall also be wise to study such details as local traffic laws to ensure that my journey ends with my arrival at the desired objective. We all have a belief in maps—it is common viewpoint which enables people to travel with certainty and serves as a basis for communication of information and ideas to others.

You may say engineers are practical men who do not understand theory. I would answer by drawing a distinction between techniques of theory which are sometimes complicated and highly specialized, and the results of a theory, namely a pattern of facts. When a fact such as the result of an engineering test stands alone, we are never sure of its validity; when it falls into a pattern, we not only feel reassured, but we see relationships that help us to predict confirmatory tests and develop a quantitative basis for confidence in our results. I am confident that teams of scientists and engineers who are saturated with this point of view will have a certainty of communication which gives them the potential to get out in front and stay there in the years to come.

Attributes of Mind

As a solution to the problem of communication of ideas in the research, development and engineering circuits, it has been suggested that one man or group follow a project all the way from research to production, scientists carrying on from research to engineering, and engineers going back to research. This method of transfer of ideas may be compared to the ionic conduction of electricity in solutions as compared with the electronic conduction in wires. It has been tried, in some cases with success, but it is a method which should be used only in emergencies and not relied upon as a general solution to the communications problem.

I have advocated strongly the establishment of unity of viewpoint in teams of scientists and engineers; I must also emphasize the necessity for diversity of talents, training and attributes of mind in those working cooperatively towards a complex technical objective. I should like to say a word or two about the significance of mental attributes. If we take a cross section of productive research workers in this country, perhaps by studying the authors of articles in the better journals, we find represented six kinds of mind, namely, (a) the creative, (b) the critical or analytical, (c) cumulative and inductive, (d) cumulative and descriptive, (e) meticulous, (f) routine industrious. It is evident that more than one of these attributes is found in any given individual, although one will generally predominate. (a) The creative mind tries to inject something new into anything it does, it may provide the flash of genius that shows up a new continent of knowledge or gives rise to a new all-embracing theory, it may throw new light on old tough problems, it may just invent an easier and better way of doing things. It is a mind that transmutes ideas from one field of experience to another. (b) The critical or analytical mind takes nothing for granted but examines keenly all statements presented to it, probing deeply into their consequences for consistency and rigor. It is the questioning mind so needed for clarification of complex situations and for establishing the validity of experience. (c) The cumulative-inductive mind ranges in the literature and in experiment, collecting facts and attempting to put them roughly in order. It is a type of mind which has contributed largely to physical chemistry. (d) The cumulative and descriptive mind is that of the trained and keen observer who remembers what he sees and describes it clearly for others to read. It is the mind which has laid the foundations of the complex sciences of astronomy, geology, and natural history. It is always evident on the frontiers of knowledge and is the stock-in-trade of the effective teacher. (e) The meticulous mind is concerned about the correctness of all details in observation, procedure and processes. It is concerned with the search for accuracy and precision. (f) Finally, we have the routine-industrious mind that follows through relentlessly, especially where many experiments are needed to establish one fact and where repetitive processes are of the essence.

History has shown that all these mental attributes have

important roles to play in the sound and steady growth of all branches of science and engineering and we should be guilty of stupid intellectual snobbery if we discounted any one of them. The meticulous worker who spends years establishing the real facts in a complex phenomenon or in perfecting a technique, or the routine-industrious man who explores an area thoroughly by a long series of measurements provide means and materials for the inductive thinker and the creative artist, materials they might not be able to get for themselves. The critical mind keeps thought and observations on the track, saving costly detours along false trails. Each has his place and the secret of the efficient use of manpower either on a laboratory scale or on a nation-wide basis lies in assigning to each mind a job suited to its attributes and carrying with it recognition of contributions to a worthwhile objective.

However, we do need more creative and imaginative minds in our national portfolio of scientific assets. We need imaginative workers who can sense significant problems, plan original methods for their solution, and point out ways in which our patterns of knowledge can be fruitfully enlarged and extended. The catalytic effect of a creative piece of work in providing new and speedier channels in which men with the other attributes of mind can devote their efforts is a phenomenon which has been demonstrated time after time in the history of science.

Throughout the centuries, the progress of science has depended on teamwork. Although each investigator planned and carried out his work in a very private manner, he took care to make his results public as soon as possible through letters to colleagues in various parts of the world or through articles in journals. As a result, the work of any investigator became available for the use of any other, it became open to criticism and extension by others, in short, all attributes of mind could be brought to bear on a scientific topic once it had been formulated and exposed by an investigator. An unorganized, but none the less effective, team made up of men from all nations quarried and polished the stones of which the structure of science is built.

In mobilizing our technical potential, we naturally think of areas of work in which national safety requires a high security classification, areas in which we cannot use the method of publication to enlist the services of all the attributes of mind necessary on a team. It is necessary, therefore, that we make special efforts to ensure that all security classified fields of work are furnished with teams diversified enough to have within themselves all the attributes of mind necessary for a sound and critical program of research and development.

I also suggest that problems in the distribution and employment of manpower could be approached more realistically on the basis of the mental attributes of scientists and engineers (similar to those I have enumerated) rather than on the basis of their professional training alone. I know many chemists who do excellent jobs as engineers or administrators and still retain their interests in chemistry, but I believe that, if creative minds are set to work on routine problems, or if routine industrious minds are given problems that depend on creative ability even in the field of their own training, frustration of the men, mediocrity of product and a general waste of manpower are the results.

Conclusion

In this paper, I have discussed the augmentation of our technical potential from a fairly general point of view in order to develop specific points of policy which will bring and keep this technical potential in a state of readiness for mobilization. I should like to recapitulate four important points which emerge from the discussion.

(1) Our research and development programs must be directed toward *clear-cut and significant objectives*—objectives set up after a thorough-going analysis of the military worth of the end items, in terms of their ability to do a significant military job with less overall expenditure of human effort. The setting up of these objectives is a task in which those having first-hand knowledge of military operations and those having first-hand knowledge of current technical problems and resources have equal responsibility, and in which modern methods of analysis offer powerful aids to sound decisions.

(2) Establishment of clear and certain channels of communication requires special attention. Two-way connections throughout the whole circuit from the assessment of significant military needs through industry to the research laboratories are essential to the swift and certain introduction of the new developments that modern warfare may require from technology. In this circuit the training of the men to operate the machines and the adaptation of the machines to the men must be included. Especially important for a group such as the Armed Forces Chemical Association is the communication of ideas in the technology circuits themselves and the establishment of a common viewpoint which enables scientists and engineers to get across their ideas to each other rapidly and effectively.

(3) I have emphasized the wisdom of having a well-stocked and extensive store of fundamental understanding as the base from which rapid advances in technology may be made when an emergency comes. Bases are built in advance. Now is the time to prepare for the future by allocating specific amounts of funds to basic research, the development of satisfying patterns of facts, and especially to the education and support of men well qualified to do this work. In my opinion, fundamental research is not a luxury, it is a basic necessity in a competitive technology.

(4) The efficient deployment of manpower has come up in several connections. Limitations on the number of highly qualified technical men suggest that their efforts be distributed in accordance with objective assessments of the payoff of the programs from the user's point of view and the realism and appropriateness of the time scales. The stability of fruitful projects must, of course, be maintained and even strengthened, but research and development projects that continue into the regions of diminishing returns not only divert trained men from more fruitful projects, they destroy technical morale by frustration. The efficient deployment of technical manpower also requires, in my opinion, a more intimate knowledge of the attributes of mind needed in a well-rounded team than is frequently seen at policy levels.

These four points, the setting up of significant and well-understood objectives, the establishment of swift and certain channels of communication, the establishment of a well stocked base from which to advance and the efficient utilization of men and their attributes have been shown to be cardinal ones in the field of research and development; you know already that they are the prime concerns of those who direct military and industrial operations.

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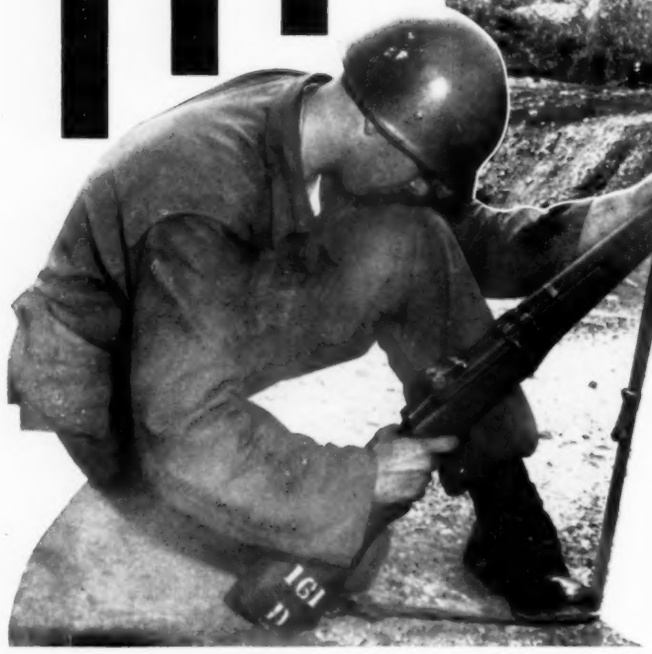
"Follow me!" A trainee squad leader moves his men forward across a deep ravine at the Chemical Replacement Training Center's close combat course at Fort McClellan, Alabama. The close combat course takes basic trainees at the Training Center through rough wooded areas to accustom them to field fighting. (U. S. Army Photo.)



Steadying his M-1 rifle by bracing his foot against the strap, a trainee at the Chemical Replacement Training Center, Fort McClellan, Alabama, fires a rifle grenade. Basic training at the Center includes learning to shoot several Army weapons including the light machine gun and chemical flame thrower in addition to the infantry rifle. (U. S. Army Photo.)

THE REPLACEMENT TRAINING CENTER

By

2d LT. JOHN P. BANJAK and CPL. EDWARD L. SMITH*

* Public Information Office Staff, Chemical Corps Training Command, Fort McClellan, Ala.

Lieutenant Colonel Edgar V. H. Bell, center, commanding officer of the Chemical Replacement Training Center, stands with his top staff members at the Training Center headquarters, Fort McClellan, Alabama. From left to right are: First Lieutenant Robert F. Gordon, S-1 (personnel officer); Captain Wendell F. Eggerman, S-3 (training officer); Colonel Bell, Captain Bruno J. Jankowicz, executive officer; and Captain William V. Young, S-4 (supply officer). (U. S. Army Photo.)

Unique in Army training is the program of the Chemical Replacement Training Center at Fort McClellan, Ala.—the only Armed Forces center which gives basic training and leadership training in chemical warfare.

At the RTC, which is one of the units under the Chemical Corps Training Command, training is divided into two parts. Recruits fresh from Army reception centers take 16 weeks of basic training; and the eight-week leaders' course is given to soldier volunteers who have completed basic training.

In command is battle-hardened, tough Lieutenant Colonel Edgar V. H. Bell, a veteran of both World War I and World War II. Colonel Bell headed the Second Chemical Mortar Battalion in Korea before he came to Fort McClellan two years ago.

Most of the instructors in the RTC are also battle-trained veterans of Korean fighting and of World War II, well-qualified by experience to instruct new soldiers.

Started in 1941 at Edgewood, Md., the RTC moved to Camp Sibert, Ala., only 30 miles from its present location, during World War II and remained there until deactivated after the war.

In September, 1950, the RTC re-opened at Edgewood under Major Leland E. Anderson, succeeded by Colonel William H. B. Howard and in November, 1950, by Major (now Lieutenant Colonel) Lucius F. Lincoln.

Although its original mission called for the RTC to train men who had already finished six weeks of basic training, in 1951 the center was expanded to give recruits a complete training cycle of basic training and chemical training. In April, 1951, the RTC was transferred to Fort McClellan as a unit of the newly activated Army Chemical Training Center (now the Chemical Corps Training Command), and later the same year re-organized to its present status of four letter training companies and the Chemical Leadership School.

Basic trainees at the center first receive eight rugged weeks of work in basic military subjects. They find out at the same time how to get along in the Army, with their leaders and their buddies, and the differences from their former civilian days.

For example they find out how the Army is organized, and learn the hard way—by "KP"—just who "does the dishes" in their company mess halls. They learn to handle, fire, take apart and put together the Army's famous M-1 rifle; they sweat over machine guns and flame throwers. All Army trainees face the gas chamber—which means going through harmless (but uncomfortable) tear gas so they can find out how gas "feels" without danger to themselves.

Trainees must know how to keep their brass shined, shoes polished, clothes neat and clean, and personal articles orderly, or else get "gigged" on inspection day.

All this, and more, the trainees at the RTC learn their first eight weeks. When they have successfully completed the first half of their training they are permitted to wear the cobalt-blue Chemical Corps scarf with their uniform.

The families of the trainees are not neglected. A letter is sent to each trainee's family when he starts training to tell about the training he will receive, the facilities to help his mental, moral, and physical welfare, and to encourage the family to write or visit the RTC, if possible.

The center has its own area at Fort McClellan, with two chapels, a service club with nightly entertainment, and two recreation buildings for each company—a lounge where trainees can watch television or write letters, and a game room. Nearby is a swimming pool and the area Post Exchange.

All ranges and training areas for the center are within two miles of the barracks area.

It is in their last eight weeks that the trainees learn the basic fundamentals of chemical warfare defense—how to decontaminate suspected areas or buildings and grounds, how

THE MISSION . . .

by LT. COL. EDGAR V. H. BELL*

The mission of the Chemical Replacement Training Center is twofold: First to develop the newly enlisted or inducted recruit into a thoroughly trained fighting infantryman, and second to further develop this young soldier into a competent basic for duty with a chemical smoke or service unit.

This dual mission is accomplished under certain policies which govern the operation of the Center; its conduct of training and its treatment of personnel.

One of the primary policies of the Center is to lay great emphasis on the first part of its mission, which is to train aggressive combat soldiers. The Center firmly believes that armies are created to fight and that wars are won by fighting soldiers and not by sitting soldiers. The young men are indoctrinated with the principals of war by the Center Commander, himself, in the first hour of the first day of their training, and the creation of the will and ability to fight is stressed throughout the entire sixteen weeks.

The conduct of training is rough, realistic, and rugged. While all of the subjets taught are considered to be important, the greatest emphasis is placed on major areas of:

1. Discipline—the cheerful, willing, eager type. The creation of a desire to obey with alacrity and spirit.
2. Knowledge and appreciation of the tools of the "trade," i.e., a rifle M-1, a gas mask, an intrenching shovel.
3. How to live in the field under combat conditions; defense against all forms of attack by the enemy and by the elements.
4. The creation of the aggressive combat spirit; to carry the fight to the foe; to win in the American way.

The Center knows that if a soldier is thoroughly trained in these four areas, he will acquit himself magnificently in any assignment in battle.

Another of the primary policies of the Chemical Replacement Training Center is that all of its men are treated as highly individual young Americans, and not as strings of serial numbers or as rows of bean cans on a grocery shelf. This treatment starts with the arrival of each shipment of trainees which is met by the Center Commander, his staff, and the officers and NCO's of company to which the new men are to be assigned. The young men are moved immediately to their quarters where their beds are made up for them with fresh sheets and newly dry cleaned blankets. There is plenty of hot water for washing up and bathing, and then a good hot meal is served regardless of the hour of arrival— day or night. Every soldier is interviewed by his Company Commander; his records are carefully checked and his personal problems are given immediate attention. This individual treatment, always decent and fair, is accorded to all men during their stay at the Center.

It must not be assumed that such treatment results in mollycoddling the young soldiers. On the contrary the trainees are considered to be men and are required to respond as such. The standards of military courtesy, the wearing of the uniform, and of soldierly behavior are very high. Discipline is strict and woe betide the violator. Punishment, always fair, is swift and sure, but very little punishment is required. Trainee absentees without leave are rare and courts-martial almost unknown in the Center. The men have great pride in their organization and it is this high esprit de corps which keeps the delinquency rate almost non-existent.

The spiritual needs of the young soldier are not neglected. Within a few days of their arrival the trainees meet with the chaplains of their faiths. These sessions are not the conventional "character guidance hours," but are informal "down to earth" talks during which the men get to know their chaplain and he their needs. On their first Sunday in the Center, the company officers and NCO's turn out at Church Call and take the new men to chapel. The chaplains are always available to the trainees for consultation and advice, and they make frequent visits to the troops while they are on the ranges and in bivouac. Church attendance is unusually high with many trainees becoming regular church goers for the first time in their lives.

The Chemical Replacement Training Center has all of the tools essential to the accomplishment of its dual mission. Its ranges and training areas are unexcelled. Training aids are more than adequate. The assigned cadre of officers and NCO's are experienced and many of them are combat veterans who have learned their lessons under fire. But far more important than these physical assets is the attitude of the cadre towards their trainees. The cadre knows that there is no more pitiful sight in war than that of a draft of poorly trained soldiers coming into a unit in combat, and they know full well the deep truth of the principle of "As they are trained so will they fight." Therefore, the officers and NCO's of the Chemical Replacement Training Center are resolved that their young soldiers go forth as the finest trained replacements in the world.

*Commanding Officer, Chemical Corps Replacement Training Center, Fort McClellan, Alabama.

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They also receive more advanced military training. They go through the rough infiltration course which makes them familiar with the sights and sounds of battle; they take close combat training and bayonet drill. And they put it all together in two weeks of bivouac training in the field.

Add it up, and in 16 weeks the raw trainees have become tough, alert soldiers, ready to go wherever the Army needs them.

On their last Saturday the trainees attend graduation exercises where they are addressed by the Post chaplain, by Colonel John R. Burns, commanding officer of the Chemical Corps Training Command, and by Colonel Bell. In the parade which follows the graduates themselves take charge and act as officers to the trainees of the other RTC companies.

All during training the graduates have competed for the title of "outstanding trainee." The winner receives the Outstanding Trainee Cup donated by Brigadier General Leonard J. Greeley, former commanding general of the Training Command. Other awards are made to the graduating company's best marksman and to the graduate scoring highest in the Army physical proficiency test.

Graduates of the RTC finish training and ship out the same day. After a short leave they report for duty again, some to Europe, Japan, or Korea, others to Army stations in the United States. For a picked handful the end of basic training means their entrance in the Chemical Leaders Course, the advanced training unit of the Replacement Training Center.

Basic training at the RTC is tough, but leadership training is even tougher. Necessarily so, because the volunteer candidates who enter the school must learn to "do it and do it right" themselves before they can lead others.

The welfare of trainees is attended to even in the field. Trainees of the Chemical Replacement Training Center, Fort McClellan, Alabama, attend services conducted by First Lieutenant Anthony G. Fagnani, assistant post chaplain.

"It was rougher in eight weeks at Leadership than basic was in 16," said one graduate of the school. "They keep you on the go from dawn to dark, and more than once I was up 'way after midnight on a field problem."

Leadership training means constant pressure on the candidates, in their white helmet liners. For instance, "double time" is the order for all movements in the troop area. Double time to reveille; double time to chow; double time to drill . . .

The school is run on a demerit system, with candidates allowed from 70 demerits their first week down to a hard 35 their last. Belt buckle out of line with your shirt front, candidate? Five demerits. Pocket unbuttoned, candidate? Two more demerits. It is not easy to stay under the limit when squad tents are inspected at least twice a day, and when personal inspection is held three to seven times a day more —usually when least expected. As a result the candidates have their shoes mirror-polished, and their uniforms clean and pressed to perfection all the time.

Candidates attend class to learn advanced military training, group speaking, and other subjects which will qualify them as Army leaders. But most of their day is spent in the field or on the parade ground. Physical training and dismounted drill are "ED" (every day) on the training schedule.

Practice in squad tactics on Fort McClellan's hilly field areas pits the candidates against officers. In their week on bivouac living in the open they are often called on to act as "Aggressors" against the "U.S." forces of basic trainees or members of the chemical service units stationed here.

The candidates have constant written tests on their classroom work, but one of the toughest tests they are called on to take is the Leadership Reaction Test out in the field. Groups of three candidates led by a fourth leave their tent area for open field along a hilly, wooded, course.

At various points on the course—just where, the candidates do not know—there are obstacles, both natural and human, to which the leader must react, just as he might as a leader in actual combat. His actions and orders to his group of men when he is confronted by each problem are a test of his training at the school, as well as of his natural instincts.

Perfection is the persistent aim of the school, ever since

(Continued on Page 60)

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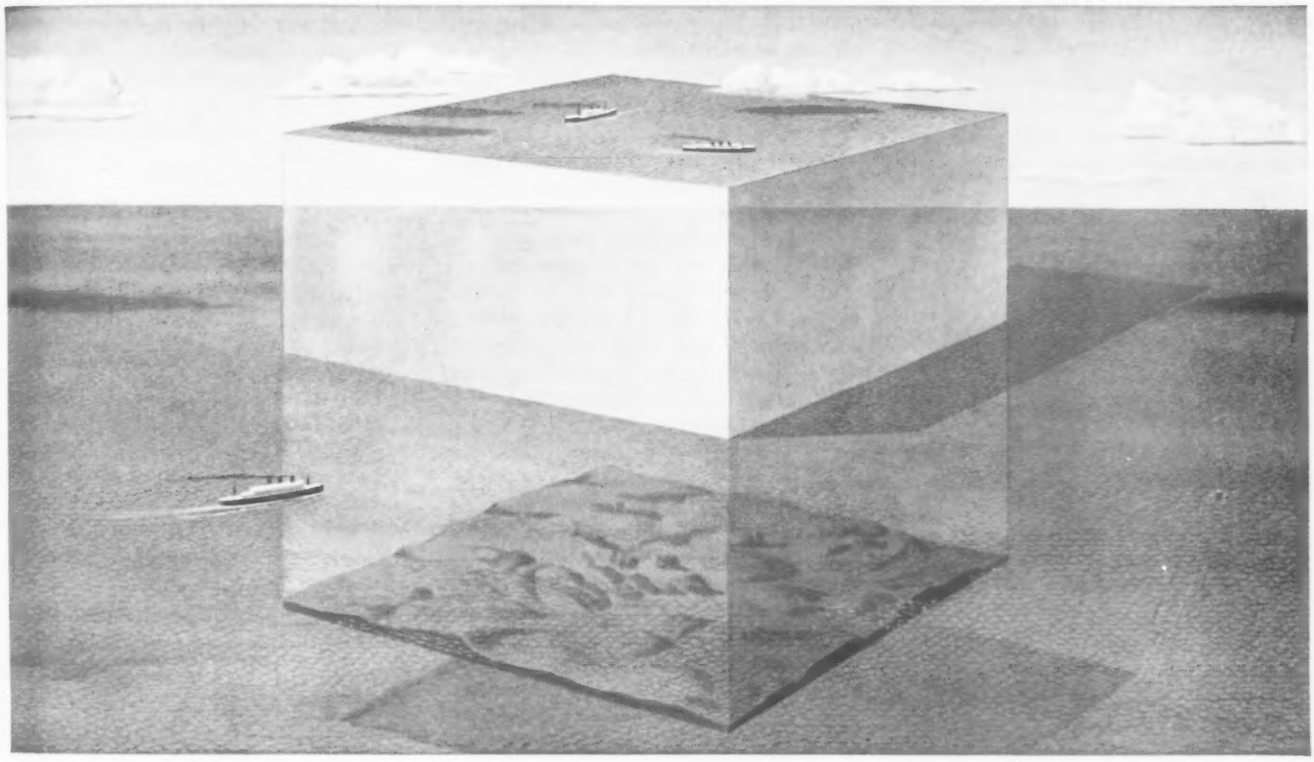

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The Session on TECHNICAL MANPOWER

ARMED FORCES CHEMICAL ASSOCIATION TECHNICAL MANPOWER COMMITTEE

DR. WALTER E. LAWSON
Chairman

A Technical Manpower Committee was appointed by the president, Mr. L. W. Munchmeyer, as a result of the discussion that took place in the Directors' Meeting held last fall. The members of our Committee were selected with care and remain the same as those originally chosen. They are:

Dr. Donald B. Keyes, Consultant
Arthur D. Little, Inc.
Colonel Harry A. Kuhn, U.S.A. Retired,
Chemical Consultant
Colonel Oscar C. Maier, U.S.A.F. Retired,
Director of Research and Development,
Pullman-Standard Car Manufacturing Company
Vice Admiral Earle W. Mills, Retired,
Chairman of the Board,
Foster Wheeler Corporation
Major General William N. Porter, U.S.A Retired,
Chairman of the Board,
Chemical Construction Company
Dr. Walter E. Lawson,
Chairman of this Committee.
Major General Melvin J. Maas, U.S.M.C Retired,
Advisor of this Committee.
Mr. L. W. Munchmeyer, President of AFCA, ex officio member

VICE ADMIRAL E. W. MILLS

We hold the firm conviction that every citizen must serve his country, and that this service should be rendered to the best of his ability; also that the Government has an equally strong responsibility of using the individual for work and in locations where the greatest service to the State can be rendered, and of maintaining a continuing annual flow of technical men to assure the superiority of our Nation during each and every year of its existence. These simple objectives are paramount to the desires of many men. Often the desires are voiced by men with the highest motives, and often they are voiced by men who trust their own group the furthest. On the other hand, if the simple convictions I have mentioned are adhered to, there is little need to worry about individual responsibility.

The general situation in manpower embodies a shortage in almost every line. The shortage is least in the uneducated, with a probable surplus among Coolies and other low class laborers, but there is a real and serious shortage as education becomes greater and the demand for highly educated men becomes more specific and more demanding. Moreover, there is no high educational limit beyond which the need for educated men drops off sharply. The discoveries in atomic physics might be limited to only a few men, but no upward limit of education could be applied. The developments in guided missiles demand the best men with special backgrounds such as could be supplied only by men who have given years of study to the subject. The future of trained men in new developments of chemical warfare, ordnance, and aeronautics demand lifetimes of training, and I happen to have been one of those who changed his opinions drastically. In World War I, I hid the fact that I was a chemist because I wanted to serve on the firing line. This situation was entirely satisfactory in World War I because we had in reserve over everyone else an advantage in the ability to manufacture and to improvise. In World War II, this condition was no longer true; and while we won this war, it was only by the scantiest of margins. I say this because I studied the developments overseas both in Germany and in Japan I know whereof I speak in technical matters through the ETO on the one hand and through Japan on the other. And now we are faced with a so-called "Korean Incident," in which Russia is outstripping us in the attention given to the technical manpower throughout the year and throughout the years. It is possible that we may outstrip them in our technical work, but if we do, it will be because we give attention each year to the development of new manpower so that there will be no hiatus in bringing forth a continual supply of replacements.

With these paragraphs forming the creed by which we have worked, it seems best to have a number of our members speak and tell you their opinions. As you listen to the elaboration of these, you will find the assurance that they are the creeds of each of us In this work we have no differences. We are working for the betterment of our country and the best special types of services by our individual citizens. Moreover, they are voiced by men who have made successful officers and who now are making succesful business men.

DR. WALTER E. LAWSON

MANPOWER FROM THE STANDPOINT OF THE DEPARTMENT OF DEFENSE

By Vice Admiral Earle W. Mills, U.S.N. (Ret.)

Dr. Lawson, President Munchmeyer, Ladies and Gentlemen: When Dr. Lawson asked me to say a few words before this meeting, he gave me as a subject, "Manpower From the Standpoint of the Department of Defense." I told Walter that I thought that subject might be misunderstood because it appears that I am in a position to give you what the Department of Defense *thinks* about the manpower problem, and I can assure you that isn't true. I have been out of the Department of Defense, out of the Navy, now for approximately four years. I have been in civil life during that time and I have enjoyed every minute of it. But I do know one thing, and I found it out by having it emphasized repeatedly—knowing that there are a number of Active Officers here as well as a number of Retired Officers—it doesn't make any difference which Service is involved, I can assure you that you will find out that when you are retired, you are *fully* retired. You don't participate any longer unless you are called upon for advice or information with respect to your own Service, or that part of Defense Organization with which you may have been familiar.

From the standpoint of manpower and from the viewpoint of National Defense, I am going to give you some of my thoughts—I hope some of them may be constructive—and if I can leave one thought with you, I think that I will have accomplished my purpose.

We had a situation in World War II that was touched on by Dr. Lawson where, I think, we were guilty in this country of downright stupidity. That may sound like a harsh statement, but it is true. I think the reason for that stupid approach to our technical manpower situation was due to the fact that we didn't have proper basic legislation to handle the matter.

I know one thing from being in a responsible position in the Navy Department, first as Deputy and then as Chief of the Bureau of Ships, I was very anxious to be sure that I could get my hands on the technical and scientific personnel that I needed. At the same time—and I think you will find it is true of all the Services with respect to such personnel—although they made a drive to make sure of technical help with the lack, as I said a while ago, of proper legislation to provide their requirements—that they turned right around and offered assistance repeatedly to Company appeals to try and get certain men deferred from the draft because they thought it was more in the interest of the national welfare to have such men continue in the jobs they were in than to draft them and bring them into the Service.

There may be some easing up of the manpower situation but we have no assurance of that fact. As I understand from Col. Kuhn, and he can probably elaborate on this more, there appears to be a reduction of draft calls in the offing that may run as much as 30 per cent. That is based on a general observation resulting from looking over requirements and from some stretch-out with respect to the Defense Programs, primarily, I think, from the standpoint of saving money and getting better utilization of the funds that we are spending, to try to reduce the total draft over the next year from about 300,000 to about 200,000. That, of course, will reduce our technical manpower requirements in a proportionate amount.

At the same time on the basis of taking personnel into the various technical branches, the requirements for deferment, to prevent those men from going into the technical branches, will be somewhat increased. It isn't just enough to have a Bachelor of Science degree, or a Bachelor of Engineering degree; but I understand you have to have that degree plus at least one year of practical or research work, if you are going to be allowed any further deferment.

I think Colonel Kuhn is much better able to talk to you on that subject than I am, and so I am going to pass on to the next phase of my talk with you, and that is to discuss why we do not have a proper basis of legislation for control of this technical manpower. We have had a little tendency, I think, to overdo the situation, and it is a perfectly normal tendency, but I want to tell you that I don't believe that we can insist on a complete deferment of scientific and engineering personnel at the expense of other professions. I don't believe that it is our intention and I don't want it to be our ultimate purpose. The objectives of all legislation and plans to control this problem are based on conservation and proper utilization of this scientific and technical manpower. That has been touched upon by Dr. Lawson. That is the objective of the Engineering Manpower Commission of the Engineering Joint Council which we work with and we agree to that principle of conservation and proper utilization.

In connection with the problem of how to get legislation introduced and passed, to become a part of the law of the land, I want to address myself to one or two thoughts on that subject.

In the first place, we have got a selling job to do. After seeing our draft boards operate on the principle that everyone must be treated alike, regardless of his background—whether he be a green grocer's clerk or a farm boy, or a technical man,—our authorities tried to emphasize that procedure. We made a very calm decision—I won't say it was a wise decision—but it certainly was one that had been thought over—that we would take the people, when their time came—unless there was some urgent family reason as to why they should be deferred. That is the program and the procedure that I referred to a while ago as being stupid because there was no consistency in the operation; and I think if you will check into the situation, you will find out that the only country engaged in World War II which was guilty of that practice was the United States.

If we can sell to our people a proper appreciation of the point that Dr. Lawson has emphasized, proper utilization, I think that we can build up a so-called "grass roots'" appreciation and reaction, so that a demand will be made on the Congress for legislation to properly handle this matter.

COL. HARRY A. KUHN

COL. OSCAR C. MAIER

One of the means by which that might be accomplished, and it would undoubtedly be in the national interest, is to have outstanding articles on the subject published at intervals in representative magazines of wide circulation. We haven't had enough of that. There have been several sporadic attempts, mostly confined to technical publications, if you please, but what I have in mind is magazines like *The Saturday Evening Post*, *Collier's*, and other magazines of widespread reader interest.

As the problems involving both shortage of technical personnel and proper utilization of those available become known throughout the nation it is hoped that a "grass roots'" conviction of the complete sense of our manpower objectives will arouse the constituency to have Congress take proper action. We certainly do not want to be guilty again of a decision that no deferments of engineers and scientists as such should be made, regardless of conditions.

We are paying a very serious price at the present time for that unfortunate decision, and it would not be too much to hope that the objectives of the Engineering Manpower Commission which I referred to a short time ago could be ordered posted in every draft board headquarters, and in every manpower agency of the Federal Government. In case you are not familiar with the exact wording of those objectives, I would like to repeat them to you, because in a few words they encompass the whole problem. Those objectives are:

To aid, and establish the importance of the engineering profession to the national economy;

To aid in maintaining the supply of trained engineers; and

To promote the most effective utilization of engineers in the interest of national health and safety.

The essential thing, of course, in this problem of selling engineering science to our citizenry is to insure that all the fallacies and misunderstandings in this problem are cleared away. Several of these have been set forth sharply by the actions of the various technical manpower committees and commissions, but I think that Dr. Warner, of Pittsburgh, put down three popular fallacies which bear repeating:

Fallacy No. 1 is that military manpower alone contributes to the defense of the United States. Certainly a great deal of the reason for our victory in the last War was not just manpower alone; but it was our tremendous technology that gave us a productive capacity that was far in excess of that of our enemies, coupled with our ability to *Control the Sea* and transport our men and materials to the places where and when needed.

Fallacy No. 2 is that all military personnel make greater sacrifices during war than civilian personnel, regardless of the positions occupied by the individuals in each group. This statement, of course, is not true in a general sense; and it is not in any way intended to detract from the great sacrifices that have to be made by the men in the Armed Services who are on the firing line. I do not want to detract from those sacrifices one iota; but I do want to say that in my own experience, I have actually known of some civilians who, after having been called into active military service under gunfire, when ordered back to shore jobs, and after having had duty there, sometimes strenuously objected to staying on such jobs and on the grind that they were subjected to and said, "For the Lord's sake, return us to combat service."

Fallacy No. 3 is that professional manpower for research, design, research and production in essential industries can be obtained from the residue after all military requirements are satisfied. That assumption, of course, is too ridiculous to brand as false, but it cannot be neglected as an idea in the minds of some of our people.

As I have tried to point out, it can be accomplished in the presentation to the public, and if the facts are presented in an effective way, I think that most of these fallacies can be removed and cleared away.

One of our very prominent social scientists, Dr. Brown of Princeton, has made an important statement in this connection, that the great and critical need for special consideration of engineers and scientists in the operation of the draft will not be easy to get across to the American people because we are not dealing with reasoned facts alone but are dealing with emotions as well; and that we are dealing with those emotions on a basis of a philosophy called the principle of "equality of sacrifice." He points out that the principle of "equality of sacrifice" runs very deeply in the minds of our countrymen.

He also indicates—and I think this is an excellent point—that there is a philosophy that is just as old and just as deeply rooted, also based on service to country; and that is the philosophy of "the highest individual contribution," and, of course, that is the meat of my whole talk. If we can get the American people to see and understand that we can stave off a war, or that we can win another war if it is forced upon us, only when each man makes his highest individual contribution, then, and then only, can we be certain that the proper utilization of manpower will determine that our Armed Forces at the front are equipped with the finest weapons that an adequate technology can produce. There certainly is no reason for believing that there will not always be a broader and more diverse field for the application of sound science and engineering efforts.

When you stop to realize that there has been more progress made in the last fifty years, technically speaking, than was made in the preceding 5,000 years, there isn't any reason for us to doubt for one second that this progress is going to continue; and that there is going to be a great mutual dependence and interest between the scientific and the technological personnel, because as you all know better than anyone else, what became, if you please, in the war seemingly new developments were nothing but problems that had been attacked and considered in the laboratories probably eight to ten years previously.

I would like to touch on one other point now, and that is in connection with our Reserves and ROTC organizations. We have a very excellent set-up the Reserve Forces Policy Board which started in its formulation, I think, in the year 1949. It was started by the Secretary of Defense, at that time, Mr. Johnson. It was a very wise move and it was instigated by a number of the technical groups, of which this organization was one. It was appreciated so much that Congress made it an official board. It is composed of a civilian chairman, a military executive who must be a Reserve Officer, and an Assistant Secretary from each Military Department, one uniformed officer of each military department, and two Reserve Officers from each Reserve component.

As you can see, the preponderance of weight in this board, therefore, is that of Reserve Officers, there being twelve against three officers of the regular Service. At present, all but two of the members of this Board are of general or flag rank. You get an excellent cross-section of personnel which is in a position to evaluate the importance of our Reserve organization, and as you ladies and gentlemen know, this country depends for its national defense primarily upon the Reserve organization. We are not fully organized except in emergencies. We are not a country that tries to maintain a large overpowering military force, but we have to depend upon our Reserve units.

The activities of this Reserve Forces Policy Board resulted in The Armed Forces Reserve Act of 1952, legislation that is excellent, but it has two defects in it. One of them is the proposal to change the aspect of the Reserve organization to provide a "Ready Reserve" that knows what it can expect, when it is going to be called upon in emergency; and that there should be provided a "Standby Reserve," which could encompass most of the technical personnel that we are talking about, in a status such that they would not be called short of

an *actual declaration of war* and thereby avoid the situation which we backed into as far as the "so-called police action" in Korea has been concerned.

The companion piece is to modify the legislation to provide for a proper setup of the Ready Reserve and the Standby Reserve, and to expand the ROTC principle so that it is uniform for all the Services. I am not saying this with any degree of showing off the Navy, but I believe, basically, that the Navy's ROTC organization is better than that of either the Army or the Air Force, and I think if we can get an ROTC organization that is similar for all the services, that we can accomplish a lot in solving our Reserve problems.

Coming back to our manpower subject, is my proposal to discuss with you the pending amendments to the Defense Act for 1952 to provide for this manpower control. That has been introduced in Congress as House Resolution 3893 and Senate 1551, both by men who know their jobs with an idea of trying to get an office created, attached to the President's Office, composed of competent persons, thoroughly familiar with the needs of the Armed Services, defense production and the national health and safety; and familiar with the functions of specialized personnel and the professions, including, of course, the engineering and physical sciences. This Board, among other things, would: Establish the criteria covering the call of Reservists to active duty; have final judgment on appeals from call to active duty involving Reservists having special proficiency or experience; establish rules for the delay in call to active duty of adequate numbers of Reservists who are qualified in engineering, the physical sciences, and other allied fields, including students in training therefor, at the graduate as well as the undergraduate levels; establish criteria for the guidance of the Department of Defense in the discharge of registrants having special proficiency or experience, who are not subject to an obligated period of service; make a continuing survey of utilization by the Armed Forces of persons having a special proficiency or experience, and report periodically the results thereof to the President.

Ladies and gentlemen, it has been a disappointment to me to find out that there has been some reluctance on the part of the Pentagon, the Department of Defense, if you please, to give unqualified support to this bill. I think the reason is that they haven't been properly approached on the subject, or that they haven't had this matter drilled into them sufficiently by taking it to the people, so that the Congress, whether the Department of Defense takes action to back this bill or not, will decide that the Armed Forces Defense Act has to be amended to provide for these important functions. If we can do that, I think we can solve our manpower problem.

But I would like to leave this one important thought with you. The best way to attain this objective is to get it across to the people of this country—The Grass Roots.

RECENT DEVELOPMENTS IN WASHINGTON

By Col. Harry A. Kuhn, U.S.A. (Ret.)

The tremendous job that American industry did during World War II is probably responsible to some extent for our technical manpower problems today, because it gave us a false sense of security. The general feeling was that we could equal the tremendous manpower resources of Russia with our industrial might and technological advances plus a balanced, resourceful, highly trained Army, Navy, and Air Force.

A little of that old fallacy of several generations past, was expressed by a leading public figure of the day, "At the sound of the bugle a million men will spring to arms" (William Jennings Bryan, 1914).

When the bugle sounded in Korea, we began immediately to mobilize our armed strength—the regular services plus reserves plus National Guard, and to lay plans to expand our industries to give us both butter and guns. The difference between 1940 and 1950 very soon became apparent. We had very little surplus industrial capacity, and we were entering a decade of decreasing technical manpower needed by an extraordinarily expanded industry. The effect of the decrease in birth rate of the depression period of the 30's was apparent in a declining college enrollment, with a proportional decrease in technical graduates, particularly engineers.

To man our expanded Armed Services we had a good supply of Senior Officers with World War II experience. However, our principal supply of Junior Officers came from more recent graduates of the Officers' Training Corps, Army, Navy, and Air Force, a large percentage of them technical men. A recent survey indicated that one-third of the chemical engineers under 26 years of age, and an even larger percentage of those over 34, were either on active duty or in reserve organizations. It became apparent that while we might have enough technical manpower to meet the initial demands of the military and industry, we could not do so for very long without some intelligent division of the supply.

A favorite American method of meeting a problem is to set up a Committee, and practically every technical organization set up a Manpower Committee. Thousands of hours were spent in debating the problem and hundreds of reports were written. The power over the distribution of technical men rested in the Armed Services and with Selective Service under laws passed by Congress. Military had the basic problem of organizing the most effective armed force. They felt that the technically trained man made the best officer, and their prime duty was to secure the best officer. Selective Service had the responsibility of securing the military requirements of the Armed Services within the age brackets established. At first it seemed like a tug of war with very little progress.

After some three years of the problem and the realization that the problem would exist for many more years, definite signs of progress are apparent. In the Department of Defense we have had two successive committees who have studied the problems and made recommendations; the first was headed by Colonel Sarnoff, and the second by Nelson Rockefeller. The Secretary of Defense has a permanent organization under the Assistant Secretary for Defense, Mr. Hannah, which considers not only the overall military requirements of manpower but, also, the technical supply.

One of the results of these studies by the Department of Defense was announced recently by Mr. Wilson, who stated that through better utilization of manpower, he expected the Army to reduce by 74,000, Navy and Marine Corps by 70,000, and the Air Force by 5,000 during the coming year. This will be reflected by a reduction in the draft calls by Selective Service. In fact, the last draft call for July of 25,000 is ½ of the rate for the past six months and 10,000 less than the originally planned call. This decreased call will give the local boards more latitude in deferring key men in industry. This draft call may later be reduced even further through an increase in enlistments and reenlistments.

An additional bright light for the future has been the announcement of regulations covering college deferments for the coming year. There have been a number of doleful stories coming out of Washington for the past five or six months that college deferments were going to be drastically reduced. Actually, the new regulations are somewhat more liberal than the previous ones. They provide for deferment examinations prior to entering college, and the passing grade has been increased only a few percent. There may be some loop holes in the present regulations to be plugged, such as father deferments for students having college deferment. There is some indication that consideration will be given

to deferment past the baccalaureate degree for those taking advance work.

A second major advance in utilization of manpower is the new organization of the Office of Defense Mobilization. That top mobilization planning agency, whose administrator, Mr. Flemming, is of Cabinet level, is the new repository of all manpower policies of the Administration. In one organization we will have draft policies, deferment policies, and all policies pertinent to manpower, both technical and otherwise. We now have outside of the Department of Defense overall responsibility of planning for both the military requirements and the requirements for civilian economy. Mr. Flemming has just selected the Assistant Administrator to handle this most important function, Mr. William J. Reid, on leave of absence from his job in charge of civic affairs for Ford Motor Company.

The Manpower Administration of the Office of Defense Mobilization will be a planning agency. The data with which they work will be secured by other Government agencies, principally the Department of Labor. This agency has been at work for some time on the problem, and has just published a joint study of the National Scientific Register of its investigation of manpower resources in chemistry and chemical engineering. It has begun a three-month's survey in industry of future demands for chemists and chemical engineers. If the Department of Defense comes up with a similar study of its requirements for chemists and chemical engineers in uniform, Mr. Reid should have part of the data on which to draft policy. No doubt one of the other speakers will touch upon the Defense and Atomic Energy Commission requirements for civilian technical manpower, a requirement which has threatened to take 50% of the available supply. This latter study should complete the data for adequate planning. The proposed method now the subject of pending legislation for actual division of the available supply of technical manpower between military and civilian economy will be a topic discussed by another speaker.

RESEARCH AND DEVELOPMENT

By Col. Oscar C. Maier, USAF (Ret.)

The speaker, Colonel Maier, spoke of research and development as applied to the technical aspects of our problem and as an aid to the manpower situation.

COLONEL OSCAR C. MAIER: I am a two-thirds integrated and unified individual. Having served with the Department of the Army for nineteen years and with the Air Force for five, I am familiar with both their problems, to some extent.

The specific subject of the application of the present fluid situation to research and development should really be in a classified state because we don't know anything much about it. We have to view with alarm, however, the admission into debate of certain safeguards that we feel are necessary to insure adequate utilization by the technical scientific organizations within the structures as now proposed.

Briefly, there will be set up under the new bill, H.R. 4304, Assistant Secretaries in the Defense Department and in each of the Armed Service Departments for research and development which gives them a voice in the councils that they had lacked.

There is a reorganization order of the President's pending which will transfer the functions of the RDB into the Defense Department under the set-up now proposed.

One of the most valuable things in RDB has been the wholehearted participation by industry in surveying the development programs of the Armed Services and that of the civilian agencies of the Government allied to the Defense program. I mean by that the Department of the Interior, Labor, Bureau of Standards, and so on.

At the present time the pressure of economy is acting to reduce very markedly the appropriations available for research and development in the near future. I feel that that is not fatal in itself. Perhaps we have saved dollarwise on research and development and added to the shortage of engineers by competitive bidding of the Services and the Government itself against the services. This, I think, is in the control of the individual Department heads and of the RDB Advisory group.

There is a new thing, however, that must be implied in the direction in which legislation is tending. Right after the war, I visited Europe on behalf of the Signal Corps and the Air Force in connection with the organization of their laboratories under the Ministry of Supply. All laboratories, all technical groups were being coordinated by the Ministry of Supply, and military personnel assigned to the Ministry of Supply were purely advisory. That is not the way we had been operating in the past. The trend in that direction, however, is very strong here.

I believe that a solid integration is possible for all services to contract. It properly belongs in the National Science Foundation. The National Science Foundation has suffered by not being understood and being considered competitive by other agencies. The National Science Foundation should at the present time be operating on the basis of about $15 million a year and it is operating, actually, on the basis of about $2 million a year. They operate in the region where there is a minimum of classification and should be a minimum of classified contract work. It should be on the basis of pure research and by the selection of scholars, scientists and physicists, who are capable of pioneering and who need support over a long term period without being bothered by this business of quarterly and monthly reports and an accounting.

There are areas which end in development work, and in turn, in weapons. These should be under the Department of Defense, and there could be a definite integration there. My personal opinion, not necessarily that of the service, that ONR has shown over a period of years an aptitude in this direction, and that the equivalent agencies in the Air Force and the Army could very well be made a joint operation with ONR to provide that special type of research which is closer to the breadboard stage and could later then be fed into Service laboratories.

The single Service responsibility which was talked about a lot and applied in minute scale does not or is not necessarily the way to do it. I think that the military manpower, technical manpower, shortage can be solved much more readily by having selected people from the various arms of the Services at the beginning of the project work together as a team, rather than as a competitive race, with neither one having the advantage of full cooperation from the other service personnel.

There is one item where the defense budget for research and development can stand improving and if your Congressman doesn't know where to cut it, you can tell him so, and that is that we have in the past two years put into the defense budget a large number of projects which more properly belong in the civil side of the government and should be carried there. Specifically, I am talking about items such as GCA and equivalent items for the departments in the government which were pushed by the Service and not carried in the civilian budget. I am also talking about projects of the Corps of Engineers, the Signal Corps and others that properly belong in a civilian agency.

I feel strongly that the universities and the industrial laboratories should continue to form and be on advisory committees under the reorganized system which is proposed as mentioned above. I think there has to be some insurance, however, that the usual political accusations will not be made, namely that the purpose of serving on the committees is to insure contracts for your specific company.

There is one other item that applies to that type of censorship by civilian agencies, and that is that it would reduce to

(Continued on Page 64)

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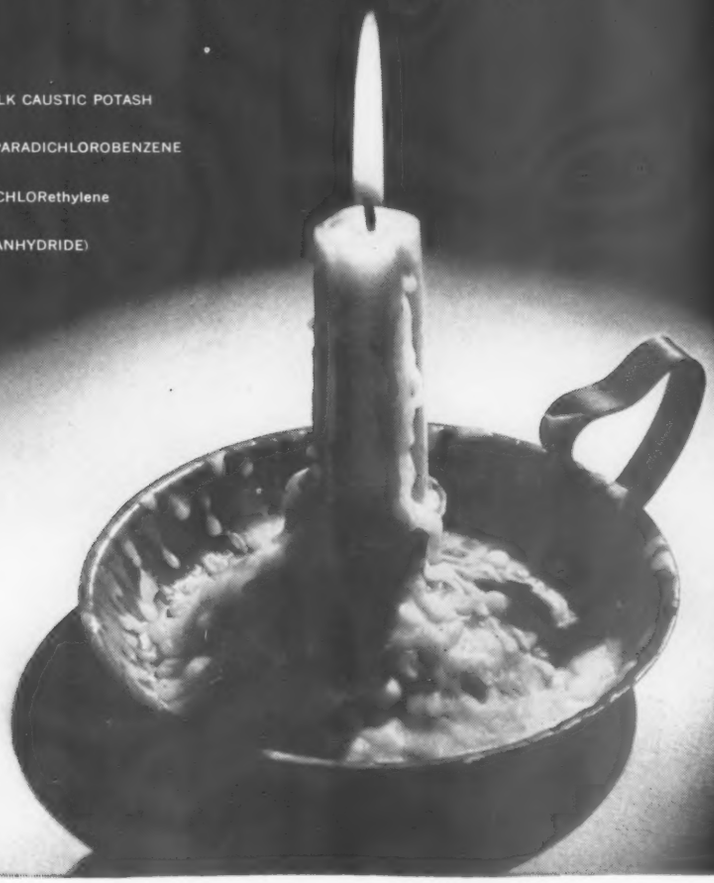

American Ingenuity + Flam

A member of the Post Chemical Office staff, Fort Lewis, Washington, demonstrates the improvised tripod mount for the mechanized flamethrower gun. Running off to the right is the fuel hose and the electric line through which the pressure cylinders are actuated. (U. S. Army Photo.)

The American is known the world over for his ingenuity, and the hardships of Korea have not dulled this ability to improvise and improve. Although flame warfare is one of the oldest weapons of combat known to man—even the caveman knew that fire would drive away his enemies—the Korean conflict has probably seen the greatest number of improvements made in its use in a proportionately short time. The ever-alert American soldier, always looking for ways to do his job better, has come up with many ideas of how to make flame a more efficient ally. Some of these ideas are still in the "field expedient" stage, others are in the serious development or engineering stage, and some may become standardized for Army use. Pictured here are four such improvements which can be considered typical of the great number that have been made.

Old Mortarmen may recognize the cart in the background. Now it carries the fuel tanks for the tripod-mounted flamethrower gun, which can be fired like a machine gun. Since the cart can be located well behind the gun position, depending upon the length of the fuel hose, the weapon is suitable for use in fixed or semi-fixed defense positions. The flame gun and pressure tanks shown here were originally developed for use in tanks. (U. S. Army Photo.)

Warfare = Improved Weapons

The use of fuel tanks from a mechanized flamethrower in connection with the gun from a portable flamethrower, gives the operator a more efficient weapon without the usual heavy load on his back. Here, a member of the Headquarters Chemical Section, 40th U. S. Infantry Division, demonstrates in Korea, how the weapon can be used. The pressure tanks can be carried forward by two men to a sheltered spot, and the flame operator can then move forward, unencumbered by the 60 pounds of the ordinary portable flamethrower on his back, to burn out any strong point holding up the advancing Infantry. The weapon can also be used in defensive positions, the distance between the operator and the fuel tanks depending upon the length of the fuel hose. (U. S. Army Photo.)

Using either the fuel tanks of a mechanized or portable flamethrower (both types visible in photo) an armored jeep offers another method of using the flame gun in burning out strong points. The above demonstration was made in Korea, using a jeep that had been armor plated by a Chemical Corp unit. (U. S. Army Photo.)

The instruction of soldiers in the use of a flamethrower is a touchy business. Here, two members of the Post Chemical Section, Fort Lewis, Washington, demonstrate a safety valve that has been inserted in the fuel line. While instructing the student operator, the instructor can keep his hand (center of photo) on the valve, cutting off the fuel supply instantly should it be necessary during the actual firing of the weapon. (U. S. Army Photo.)

THE ATOMIC FUEL HORIZON

By HARRY A. WINNE, Vice President
General Electric Company, Schenectady, N. Y.

Prior to August 1945, the title of this talk "The Atomic Fuel Horizon" would have had meaning for only a very small fraction of a percent of the people in this, or any other, country, even perhaps in such an erudite audience as this. Today it seems to have meaning for almost everyone, but its meaning varies terrifically among individuals. To one group of extremists it means "Heaven," and to another "Hell," with all possible gradations between the two.

Most of you undoubtedly remember that in the days and weeks immediately following the explosion of the atomic bomb on August 6, 1945, many extremely rosy and fanciful predictions were made as to the effect which peacetime uses of this strange new source of energy would have on our daily lives. Often heard were expressions such as "revolutionary!"; "it will lift the burden of toil from the human race"; "electric power for everyone at unbelievably low costs"; and so on. On the other hand, many pessimists thought atomic energy would bring about the end of the world.

Illustrative of the optimistic thinking—and interest—is the fact that within two weeks after August 6, 1945, there came to my office in Schenectady representatives of the engineering department of one of the major railroads of the country. They wished our opinion as to whether they should go ahead with their planned program for new locomotives, or whether atomic energy would have such a major and immediate effect that entirely different systems of motive power should be considered. Fortunately, we advised them to go right ahead with their plans on the basis of then conventional motive power; that in our opinion it would be decades before atomic energy could compete commercially with other sources of power for general peacetime purposes.

At the same time there were many optimistic estimates as to the time scale of this "revolution." One noted scientist said "ten years from now (late 1945) atomic power could be a very important factor in our national economy." Of course, he said "could be," and the ten-year period has not quite passed. An important industrialist thought it would be possible within a decade to build an atomic power plant which could compete with a coal-fired plant. A high government official was of the opinion that atomic energy could be harnessed within a year for peacetime purposes. Not all were so optimistic. A noted educator thought the development would be slow and gradual. Incidentally, so did I, and I still do.

Today there appears to be a considerable resurgence of optimistic opinion with respect to atomic power for industrial use. I am sure most of you are aware of this from articles which have recently appeared in the public press and in technical magazines. Much of this present optimism is in my opinion, *if properly interpreted*, reasonably soundly based. The trouble is a considerable number of the optimistic statements which have been made are subject to optimistic misinterpretation, which may lead to false hopes.

Well, admitting that the optimistic forecasts of 1945 have failed of realization, what can we really expect? Here are some pertinent questions.

Dare we plan on obtaining useful power from the atom?

If so, what will be its cost?

When may we have it?

Can atomic-electric power plants be operated safely in populated areas?

Is there available a significant amount of atomic, or nuclear, fuel?

Will nuclear fuel displace coal, oil, gas, or other conventional fuels?

What may be some of the first applications of atomic-electric power?

Has this development advanced too slowly, and, if so, why?

What can be done to speed the development?

What may be the ultimate effects of peacetime uses of atomic energy?

This is a group of pretty formidable questions. Even with the best crystal ball our research laboratory has been able to produce to date, I cannot find definite answers to all, or even to most, of them. But I am quite willing to speculate on these problems with you, and perhaps we can develop some rough approximations to the answers. So let us consider these questions one by one.

First, dare we plan on obtaining useful power from the atom? I will give a very definite "yes" as the answer, and then I want to do some explaining. I believe that what most of us mean by "useful power" is electric power. I think this is basically sound, and so I want to talk about what we may term atomic-electric power plants. Parenthetically, in all my discussion, I am omitting atomic weapons, although these, to date, are probably our most useful applications of power from the atom.

In an atomic-electric power plant, an atomic pile—or, to be technical, a nuclear reactor—will generate heat due to the fission, or splitting, of atoms of uranium or plutonium. This heat then will produce steam to operate a conventional steam turbine driving an electric generator.

Of course, it would be very nice if we could convert directly

to electric power the energy released from the splitting atoms, but there seems to be no known or probable way of doing this on a reasonable scale, so, today at least, we have to think of the atomic pile as essentially a steam generator, which could replace the steam boiler and fuel and ash handling facilities of the ordinary fuel-fired power plant. From the point where the steam comes out of the boiler room, essentially no change in the plant would be necessary.

I think I am safe in saying that such a power plant can be designed and built today. In fact, a small experimental plant of this nature has already been operated, and two atomic power plants for submarine propulsion are now under construction. There are lots of technical problems involved in the design and building of such a power unit, and we won't know whether we have solved all of them successfully until the units have been built and operated for some length of time. I am sure we have, or will find, ways of solving them.

We know in general the kinds of materials that may be used. We know pile configurations that will work. We know how to control the power output of the pile. We know how to shield it to prevent danger to personnel.

But, we do not know how to build and operate it at a reasonably competitive cost. So now let's discuss the second of my opening questions, namely cost.

As you probably know, there are four or five industry groups or teams which, under contracts with the Atomic Energy Commission, are now studying the economic possibilities of building atomic-electric power plants. These studies have already produced some very worth-while information, and I hope they will continue. One of the groups has been augmented by the addition of quite a large number of power companies, and its studies are definitely going forward. This interest and activity by the electric power industry is very heartening, for I feel strongly that we must look to industry to bring the development of economical atomic-electric power to fruition.

Some of these studies are based on an atomic pile which produces both plutonium for weapon purposes, and heat to generate power. This is technically perfectly practicable. In fact, the Hanford piles today produce plutonium and tremendous quantities of heat, although their design does not make it feasible to use this heat for power generation.

I would guess that these studies will show that—based on any pile designs we know today—such installations could produce electric power at competitive costs only if the power is essentially a by-product of plutonium production. Our government is the only customer for plutonium at present, although perhaps other governments would like to buy some. So, presumably such plants could live economically only so long as the government guarantees the market and price for plutonium.

In my opinion, this situation does not constitute a sound basis for an atomic-electric power industry. It will really be economically sound only when it can compete with conventional electric power without requiring a government-supported weapons market. It could not do that today—unless in some very peculiar and unusual circumstances—nor, in my opinion, for a good many years to come.

Well, what can we expect in the way of cost? Let's consider fuel costs. I think it quite within the bounds of possibility that, on the basis of cost per Btu content, atomic fuel may become very significantly cheaper than conventional fuel. But we must remember that, of the average price a consumer pays for electric power today, only about 20% represents the cost of fuel, so even if the atomic fuel cost were zero, there would be no hope of fulfilling the forecasts of some of the over-enthusiastic, early atomic prophets.

What about operating costs? I cannot see that these will be greatly different than in conventional plants, although conceivably they might be slightly lower.

The major cost problem today is the first cost. Since the atomic pile will replace only the boiler and fuel-handling equipment, their cost is our target. In a large modern station, this part of the plant cost amounts to from $75 to $100 per electrical kilowatt capacity. Public knowledge of corresponding atomic pile costs is rather meager. Dr. L. R. Hafstad, of the A.E.C. organization, speaking in May 1950 said that the average cost of four then projected large research reactors was approximately $10,000 per equivalent electrical kilowatt. Dr. Donald Loughridge, also of A.E.C., speaking in December 1952, gave the estimated cost per kilowatt for the atomic plant in the first nuclear-powered submarine as of the order of magnitude of $1400. He also pointed out that the submarine plant necessarily involved many very special features, and that consequently he thought a fairer figure for a land type plant might be of the order of $500 to $600 per kilowatt. This is still a long way from $100, but isn't it encouraging to note how rapidly the estimated cost has dropped?

And I am sure it will continue to drop—though probably not at this rate—as we gain knowledge and experience in building atomic plants, until, I firmly believe, we shall build atomic-electric power plants which can compete economically with coal or oil or gas-fired plants. But this, I think, is going to take a long time, time probably measured in decades rather than years.

And so we come to my next question: when? Now let me emphasize that I am asking when can we have an economically sound atomic-electric power industry—not just when can we have one, or two, or three large atomic-electric power stations. Those, if we want to pay for them, and for their operation, we can have rather quickly, possibly in five years or less. I want to distinguish between developing an industry, or an economy, and developing what I call a "gadget." The atomic bomb was a "gadget." The first nuclear-powered submarine may be termed a "gadget." Very important and very useful gadgets, true, but "gadgets" nevertheless, gadgets which we can afford only because of very special circumstances, in this case the circumstance being the stupidity of the human race—or parts of the human race—which brings about one war after another. A gadget can be built quickly, by a "crash" program with unlimited funds. An industry cannot. But by building suitable gadgets we can gain knowledge and experience which will help to build an industry.

Let me illustrate the reason for my belief by citing the case of the gas turbine. The fundamental theory of the gas turbine was well known before the turn of the century. But, to make it practical, metallurgists had to develop new high-temperature alloys, engineers had to gain new aerodynamic knowledge in order to design turbines and compressors of adequate efficiency, manufacturers had to develop new methods of machining and fabrication. If the production of an operating gas turbine fifty years ago had been a command performance—as was the manufacture of an atomic bomb in the early forties—a working unit would probably have resulted, but I hesitate to think what its cost would have been.

But an economical unit could not have been achieved then, nor for many, many years. Fifty years ago the necessary knowledge of materials and fabrication was not available. More than that, the tools to develop this knowledge were not in existence. There were no industrial X-rays, no spectroscopes, no stainless steels, no arc welding equipment, no electric furnaces. Some of the metallic alloying elements we use today had not even been discovered. These are all part of the "favorable climate" required for the sane, economical development of the gas turbine.

What new tools and new knowledge do we need in order to build economical atomic-electric power plants? I don't know, but I am reasonably sure we shall find them in the decades—and I mean decades—to come.

So this question of "when" is one I cannot answer with any accuracy, but I do feel certain that at least fifteen years will pass before atomic-electric power plants are making any

significant, economically sound contribution to our power generation capacity, and I think quite possibly double that time may be required.

You may think this statement differs greatly from others which you have heard or read recently, but I think you should examine these carefully. I saw one made recently by a prominent industrialist, to the effect that we can have a central station plant producing electric power from atomic energy within five years. I believe this is probably true, but if in your thinking you subconsciously insert the words "at competitive costs," then you make it untrue.

Again I want to emphasize that my long term estimates refer to the development of a competitive industry, not to the building of a power station.

Now the question: can atomic-electric power plants be operated safely in populated areas? My answer is yes, but for psychological reasons it may not be advisable to so locate a plant for some time to come. With our minds filled with thoughts of the terrors of atomic warfare, the destruction that can be wrought by the atomic bomb, the fear of the invisible, intangible, odorless, insidious, death-dealing radiation effects, it is difficult for us to take a non-emotional view of the possible hazards surrounding such a plant.

But let me point out that the great Hanford plant, designed and built, one might say with no experience and little knowledge compared to what we have today, has operated for almost ten years with no injury to any person from radiation or any other factor peculiar to atomic energy. In fact, its over-all safety record surpasses that of any other of our General Electric plants.

I believe an atomic-electric operation need be no more hazardous than many others which we do not hesitate to permit in populated areas.

Next question!—Is there a significant amount of atomic fuel available? For the long term—yes! At present, a great share of the uranium used in the western world comes from the Belgian Congo. However, natural uranium is pretty widely distributed throughout the earth, though most of the deposits are of low grade. Workable deposits have been found in the Colorado plateau and in Canada. There are substantial quantities in the tailing piles of the South African gold mines. Phosphate rock in Florida is another source.

While fissionable uranium 235 constitutes only 0.7% of natural uranium, it is fairly certain that the processes known as conversion, or breeding, carried on in an atomic pile at the same time it is producing heat for power purposes, will ultimately make it possible to convert a large part of the 140-times more abundant uranium 238, and also of thorium, to fissionable material. Phosphate rock may contain from 0.2 to 0.4 pound of natural uranium per ton of rock. About one million tons of this rock are used per year for wet process phosphoric acid production from which it seems feasible to extract uranium. A great deal more is used for the production of super-phosphate. If we assume that this one million tons have an average of 0.3 pound of uranium per ton and that we could recover economically two-thirds of this, we would have 200,000 pounds of uranium. Now assuming that through breeding and conversion, we are able to utilize half of this, namely, 100,000 pounds, as atomic fuel, we have the equivalent in heating value of 150 million tons of coal, or about 30% to 35% of our present annual usage of coal, from this one source alone.

Under the sponsorship of the A.E.C., a consulting engineer, Mr. Palmer Putnam, has made a survey of the fuel usage and fuel reserves of the world. He concludes that, assuming conversion and breeding permit using U-238 as well as U-235, the energy in economically obtainable uranium is more than 15 times that available in the presently known oil, gas and usable coal reserves of the world. Our usage of electric and other forms of power is increasing at a tremendous rate. Consequently, nuclear fuel may well prove a very welcome addition to our energy reserves, and may become the bridge necessary to support our civilization in making its transition from the use of energy from combustible fuels to the employment of that last resource, energy from the sun.

As to whether atomic fuel will completely displace coal, oil, or gas, I think not, except as these may become less available, or in circumstances particularly favorable to atomic energy. Never has any new fuel completely displaced an existing one. Each gradually finds its most useful fields. In other words, nuclear fuel will supplement, and not supplant, combustible fuels.

Now let us consider some possible, near-future applications of atomic-electric power plants. An important determining factor is the great concentration of energy in nuclear fuel. The energy content of one pound of nuclear fuel is equal to that in about 3 million pounds of coal.

It is probable that the first practical application of atomic power in this country will be to a submarine power plant. Both the General Electric Company and the Westinghouse Electric Corporation are designing and building such plants for the Navy.

The energy in the initial fuel charge could be sufficient to permit the submarine to operate for a number of months without requiring additional fuel. Furthermore, atomic fuel does not require combustion with air to liberate its energy. Therefore, a submarine should be capable of operating submerged at full power and for very long periods of time. This would of course be a tremendous tactical advantage.

As you also know, the Air Force is very actively interested in the application of atomic power to aircraft, and the General Electric Company, Pratt & Whitney, and others are working on this application.

While the light weight of the fuel, and the long range which it would permit, are great advantages, the necessity for heavy shielding is a distinct disadvantage, and so this application involves very difficult scientific and technical problems.

The heavy shielding required precludes any possibility of application to automobiles or similar vehicles. It may be possible some day to build an atomic power plant for locomotive application. Because nuclear fuel is such an extremely concentrated source of energy, it may, before it comes into more general use, bring economical electric power to areas where the transportation costs on ordinary fuel are extremely high. However, to be efficient and economical, I think an atomic power plant will necessarily be of large capacity, except perhaps for military or other special situations.

We hear frequent criticism to the effect that the development of the peacetime use of atomic energy has proceeded much too slowly. Well, perhaps so. Certainly it would be nice if we had economical atomic-electric power available today. But I am not at all sure that heavy additional developmental expenditures, above and beyond the programs under way, would have been justified. As I have indicated previously in my remarks about the gas turbine, I think the development of a climate favorable to nuturing a sound new industry is dependent on a lot of more or less extraneous factors, and requires time, and quite a lot of it.

What can be done to insure optimum speed of this desirable development? We need to get experience in designing, building, and operating sizable power-producing reactors. This we are doing in connection with the power plants for submarines, and for a large naval ship. Following these, and based on knowledge gained from them, next steps should be taken. Perhaps one of the dual-purpose reactors should be built. Lots of studies should and will be carried on.

Unless we need more reactors for weapons production, in which case we should by all means consider the possibility of building these as "dual market" reactors, that is, capable of producing both plutonium and power, I have grave doubts whether we should incur the heavy expense required if we

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Driers, Naphthenate, Liquid, Concentrated (TT-D-643a Type I, Lead 24%; Type II, Cobalt, 6%; Type III, Manganese 6%; Type IV, Zinc 8%)
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Linoleate, Lead (MIL-L-17190 Ships)
Linoleate, Manganese (MIL-M-15188A)
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Magnesium Stearate (ammunition) (JAN-M-542 Amend. 1); (ointment) (JAN-M-560)
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INDUSTRY'S REACTION TO GOVERNMENT PROCUREMENT PROCEDURE

By W. D. WILKINSON
Monarch Aluminum Mfg. Co.

We are in a butter and guns economy whether we like it or not, and we will be in that economy until such time as man recognizes the dignity of man, regardless of the flag to which he pays allegiance. Industry must recognize that there are obligations to the government that they must shoulder in much the same spirit as the men of Valley Forge, Gettysburg, Verdun, Tarawa, and Korea. Our government does not ask us to produce and provide the necessary equipment so that we can be a strong nation at a financial loss, but they do ask us to produce equipment to the best of our ability at a reasonable profit. They ask us to shoulder a portion of their responsibilities and work closely with them as a team and not to look to a government contract as a stop gap to fill in a lull in civilian business, as during a time when we cannot get materials to produce our normal products.

Who is this government? It is you and I. We are working for ourselves to make sure that the church we attend will be there tomorrow, and that no man will deny us the rights and dignities which were born in Constitution Hall. Then what is the tie-up on this team of industry and government? What is the stumbling block that retards production and greys the heads of industry and government alike? The almost unanimous answer seems to be procurement.

At the mid-winter meeting of the Midwest Chapter of the Armed Forces Chemical Association, a panel discussion was held on the subject of what could the A.F.C.A. do for industry, the reserve officer, the procurement district, and the individual—and likewise, what could these same people do for the A.F.C.A. The suggestion was made of sending a questionnaire to industry to find out how procurement looks in the eyes of industry. In the August 23, 1952, issue of the magazine *Business Week*, the results of such a survey that had been conducted by Brig. Gen. W. Preston Cordiman, commanding officer of the Signal Corps Supply Agency at Philadelphia, had been published. The suggestion was favored, and a committee was formed to conduct the project.

What questions should we ask? Would it not be best to make the questions serve almost as an outline starting from the time of contact to learn about procurements and following on through the various steps that such an experience would reveal. In this light the questionnaire was prepared covering twenty-two points and it was made ready for mailing.

What would give us the best cross section of industry and the most significant reaction to doing business with the government? We turned to the Chicago Chemical Procurement District who supplied us with a list of successful contractors and also a list of firms who were second and third bidders on most of the same contracts. Geographically these firms extended from California to New York, and from Minnesota to the Deep South. They represented all types of industry, from chemical companies to metal fabricators, from small business to big business. It was indeed a true cross section of industry to be used as a sample for our questionnaire.

The firms contacted were urged to feel free to comment on their experiences with all military procurement agencies with which they have had dealings, and merely to indicate on the questionnaire when other agencies were involved. In the interest of anonimity, the questionnaires were returned to us in a plain envelope.

Our percent of returns ran 49.2% and the results of these returns were tabulated and presented at the national meeting of the A.F.C.A. in New York on May 20th.

The first question asked was, "Did you have any trouble in getting on the bidders' lists or in receiving information about procurements that were coming up?" The returns showed that 83.8% did not have any trouble. The balance had trouble. In respect to replies regarding other agencies, one replied that he had trouble, and another did not. This high percent of firms not having trouble clearly shows that an agency of our government was most certainly co-operative on this initial step.

The second question was, "Did you experience any trouble obtaining information regarding the details of the bid?" The reply to this question showed 100% that firms had no trouble in obtaining the necessary information. Those that reported on other agencies showed that one had trouble and one did not.

Question Number Three was, "Was the time ample for you to formulate your best bid?" 74.2% replied that they had ample time for formulating their best bid. The balance replied that they did not have enough time. There were three replies regarding other agencies, and these stated that they did not have enough time.

Question Number Four dealt with a very controversial point in that we asked, "Which do you prefer,—Negotiated or Advertised Bids—and why?" 60% preferred Negotiated bids. 20% preferred Advertised bids. The other 20% preferred the use of both types of bids. There were many comments voiced on the preference for Negotiated bids, and following are two such comments:

"Negotiated, because there is time to work out the price and negotiate a fair profit for the job. Advertised bids of previously purchased items often result in price cutting below a fair profit."

"Negotiated bids. Requests for proposals for negotiated bids are usually restricted to qualified contractors and such proposals allow both the contractor and the contracting officer to review the proposals and eliminate any obvious errors. An Advertised bid in many cases is a result of misinterpretation of specifications or prints, or is due to inexperience with such work."

There were comments also from those who preferred Advertised bids, and following are two such comments on this preference:

"Advertised—Equal competition."

"Advertised—Small business can't compete with big business, due to representation at bidding point."

In respect to the comments on the preference for both types of bids, there were many interesting views presented, and the following are two such views which express the general feeling in the best manner:

"This depends on the type of item being purchased. Standard and commercially available items can probably be purchased by advertised bids. However, highly specialized items such as fuzes, firing devices, and other types of munitions we feel should be purchased by negotiated bids."

"Advertised OK on standard items. Negotiated on new products to ensure getting complete details on desires of Procurement Agency."

Question Number Five might be classified as the ethics of Negotiated bids, for here we asked, "Do you think that practices of negotiating a bid are in keeping with normal business practices?" 78.3% replied that the practices were in keeping with normal business practices. The remaining percent felt that they were not in keeping with normal business practices. Two firms replied, in reference to other agencies, that the practices were not in keeping with normal business.

Question Number Six dealt with matters of schedules, and here we asked, "Were the schedules in the bids realistic from the standpoint of your being able to produce the item starting with scratch?" 37.9% answered that the schedules were realistic. The balance, 62.1%, said the schedules were not realistic. The comments about the schedules being realistic were very few, and one firm best presented that in his comment, "Where they specified standard industrial equipment—yes." Those that commented about schedules not being realistic said the following:

"Delivery schedules are in many instances not realistic. There are many instances where business was placed with a vendor on an unrealistic shipping schedule which was not and could not be maintained, to the disadvantage of others who bid it in good faith."

"No, in most instances schedules do not allow sufficient make ready and starting time. Also, were unrealistic from viewpoint of possible delivery of government facilities."

"In some cases in the past the delivery dates requested were not consistent with the situation as to availability of material."

In our seventh question we asked it in two parts. In the first part we asked, "In your interpretation, are the determining factors in choosing the lowest bidder sound?" 53.3% said that the determining factors were sound. 26.6% said they were not sound. 20.1% replied that they were not always sound. One firm replied, regarding other agencies, that they were not sound. In part two of this question we asked, "In your opinion, what should be the prime determining factor in choosing a sound lowest responsible bidder?"

13 rated ability to produce as the prime factor
8 chose facilities for production
8 held with past performance and reputation
7 chose price
5 "know-how"
4 personnel
2 financial stability
2 credit standing
2 ability to meet delivery schedules
1 engineering plant ability.

Question Number Eight was also divided into two parts. In part one we asked, "In the event that you are the unsuccessful bidder, what information did you receive on the award?" 53.3% said they received no information. 40% said they were informed of the results. 6.7% replied that they were not informed in all cases. Three firms replied that they were not informed by other government agencies. The second part of this question was, "What information would you like to receive in such a case?" 58.3% wanted the name of the successful bidder and the price bid. 33.3% wanted a complete tabulation of the bid. 8.4% asked for a quicker release of information regarding the outcome of the bid.

Question Number Nine had three parts,—part one being, "Where the government was to furnish certain equipment and material, did it arrive in time so as not to hold you up in your production?" 52.9% reported that the equipment arrived in time. The remaining percent said the equipment did not arrive in time. Three replied that the equipment did not arrive in time in respect to other agencies. Part two was, "Was the equipment what you expected?" 58.8% replied that the equipment was not up to expectation. The remaining percent replied that it was up to expectation. In respect to other agencies, one replied that it was and one reported that it was not up to expectations. Part three asked, "On government furnished material, was it to the standards as outlined in the bid?" 47.3% replied that it was to bid standard. 42.2% replied that it was not to bid standards. 10.5% said that it was approximately to bid standards. One reported, in reference to other agencies, that it was not to bid standards.

On Question Number Ten, "Did you receive adequate assistance in obtaining critical material?", 54.2% reported that they received adequate assistance. 31.8% reported a lack of assistance. 14% replied that they did not need assistance. In reference to other agencies, one received and one did not receive adequate assistance.

On Question Number Eleven, "Were you advised of the necessary inspection standards and controls and contractor's responsibilities before starting production?", 51.4% reported that they had been advised, and 48.6% replied that they had not been advised. Again, we had one vote yes and one vote no regarding other agencies.

Question Number Twelve was, "Taking into consideration the human element, do you think the government inspectors are fair?" Following is a tabulation of the replies to this question, and since they are so varied, they are not broken down by percent:

16 said inspectors are fair
4 said inspectors are not fair
2 said the inspectors are not well informed
1 said inspectors are too much of a problem
2 said half the time the inspectors are fair
1 is doubtful if they are fair.

Question Number Thirteen was, "Where the matter to be decided was borderline, in your opinion was the decision of the government fair?" Again, we will submit to you the tabulation of the replies for your analysis. They were:

15 said the decision was fair
5 said the decision was not fair
1 said the decision was normal
1 said the decision was not always fair
1 had them both ways.

Question Number Fourteen was, "Did you experience any trouble with specification requirements on what you believed to be good functional material but not to the letter of the specification?" 80% replied that they had trouble. 20% said they did not have trouble. One replied that he had trouble with other agencies. The comments of those who had trouble with specifications were as follows, and I quote two:

"Have had considerable difficulty in this respect. Finally waivers were granted but required too long to obtain and brought about delays."

"Occasionally yes, but each time the problem has been worked out satisfactorily with the proper contracting authorities."

There was a comment from which I think we could all learn a lesson, in respect to not having trouble. It was, "No, we always submit a request for deviation prior to the use of such material, and the cooperation of most Government Agencies has been excellent."

Question Number Fifteen was, "Were drawings and specifications embodied in contract as awarded complete and practical from a production standpoint?" 42.3% replied that they were not practical. 42.3% replied they were practical. 11.7% said that they were practical most of the time. 3.7% had varied experiences. One replied that they were not practical in respect to other agencies.

Question Number Sixteen was, "What was your experience in regard to obtaining engineering changes from the government which would facilitate the best production of the item under contract?" Some of the replies listed more than one

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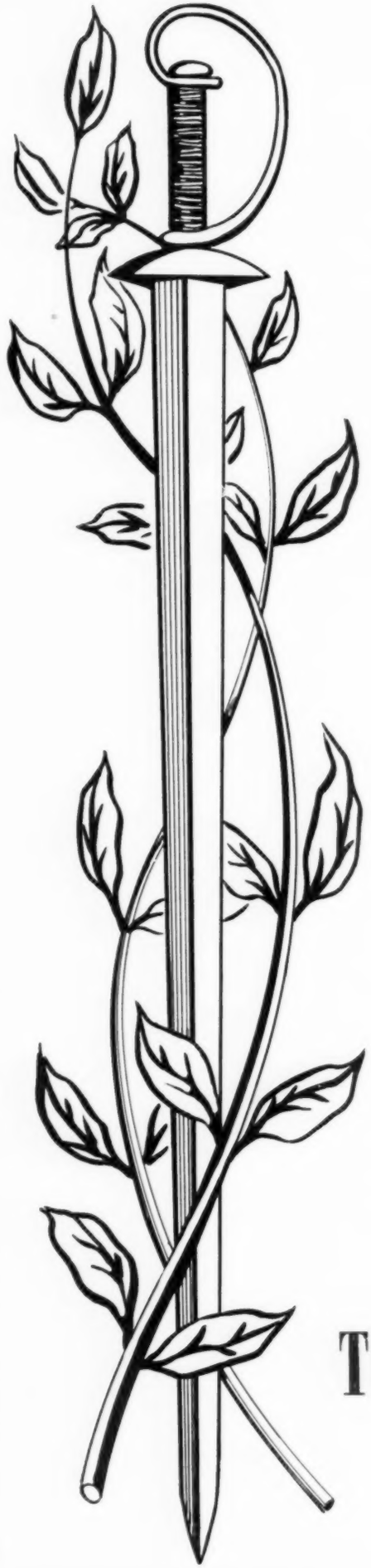


THE CHEMICAL INDUSTRY

By GENERAL BREHON SOMERVELL

An address given before the Industrial Council, sponsored by Rensselaer Polytechnic Institute, Troy, New York, May 16, 1953.

The past, the present and the future of the Chemical Industry in our country constitute a record of achievement, a foundation for security, and a promise for tomorrow.

With the state, as with the individual, the first duty and obligation is that of self-preservation. This is recognized in the Preamble to our Constitution and although, fortunately, necessity has not always kept this precept in the forefront of our thinking, especially in the years when our nation enjoyed long periods of peace, and freedom from aggression. Events of the first half of this century and more especially those of the last decade once more make it crystal clear —brilliantly clear as it was to the founding fathers of our nation.

My part of the program is devoted to the relationship of our industry to this first duty of all citizens of this nation, the preservation of our Republic and of our way of life. The struggles of World War II and events in subsequent years have imposed world leadership on the United States. From time to time I have felt obligated to remind those to whom I have spoken that, to exercise this leadership, we must be strong morally, economically and militarily. As we cannot hope to equal or exceed our potential enemy in point of numbers, our superiority must come from our inventive genius and a strong industry to support it. Peace-shattering events since 1946 have served only to emphasize the truth and application of this premise. Tonight my remarks will be in extension of this statement as it relates to Chemicals.

During the long and fateful days of World War II, we all prayed for peace. Late in 1945, we believed that peace had come. One gang of dictators, whose basic concept of life was enslavement, had been subdued. But there was no peace. One of our former allies, another dictator, started a broad conquest of his own. In the last eight years we have seen small and large nations swallowed by the Communists, and our relations with the Kremlin have been strained almost to the breaking point.

We emerged from World War II with leadership for the free world thrust upon us. We are looked to for guidance and support by the freedom-loving people of the universe in their war with Marxism and totalitarianism. For four years we were able to keep this war cold, although the fires of active war were smouldering.

Then, in June, 1950, the Communists' invasion of South Korea sounded the third alarm in the lives of many of us. We had to make an immediate military and economic decision—to what extent should our military and production forces be mobilized?

There were three choices: First, total mobilization of all our resources, assuming an early all-out war with the Russians; second, no mobilization at all, allowing Communism to take whatever the Kremlin wanted, whenever and wherever it wanted it; or third, a middle course somewhere between these two extremes.

Large-scale industrial disruption would have resulted from total mobilization, and we would have gone through a cycle of disorderly expansion with its inefficiencies, and finally, when we were completely ready, back to the unemployment phase. Then we would have found that our stockpile was already obsolete and that we would have to retool to stay in the fight. On the other hand, we could not allow Russia to march on unchallenged.

So we took the middle course: To mobilize the forces and production we needed for the conflict in Korea, then set the throttle at a speed that would keep things moving and at the same time allow for a small build-up in reserves.

Thus, today, we find that we are exporting chemicals everywhere, farm tools to South America, radios to Africa, wheat to India, tourists to Europe—and the munitions of war to the Orient. This has been accomplished with minimum industrial disruption and no violent dislocations in the civilian economy.

We are at war, whether we wanted to be or not. True, in a sense it is a minor war, but from it we have seen the pattern of the future. There is no easy way ahead. We must keep prepared for war for many years to come. As long as we believe in freedom, as long as any other

nation intends to destroy our way of life, and as long as our national wealth is coveted by any other nation, we will find it necessary to defend our existence —perhaps again without warning. A strong defense must become a continuing part of our government until a just and total peace is a reality. We must, at all times, be ready to shift the throttle forward and increase our present effort to total mobilization. We cannot falter, for should we let down our efforts on behalf of the free world, the Iron Curtain would drop with a splash into the English Channel and the Bamboo Curtain would roll down around all of Asia. The key to the maintenance of our way of life—freedom—is contained in three words: "Sustained intelligent effort."

Basically, there is one thing we must remember in any discussion on this subject: That America's strength as a world power lies in large measure in its chemical industry. Chemicals, in one form or another, play an increasingly important part in every phase of our existence. Among all of the sciences, none touches us in our daily lives so intimately and so often as does chemistry.

It is self-evident that a nation without access to a strong production program cannot sustain a strong military effort. War poses complex manufacturing problems, drawing upon all of the ingenuity and skill of man. From our production lines must come the goods that make our soldier facing the enemy the better equipped of the two, so that given good leadership and logistic support, he will be the victor.

Here are two facts that add up into one thought: First, almost every American production process must rely upon the chemical industry for some item; second, America's biggest industry is now the chemical industry; the resulting thought: A key to America's strength in a defense program lies in its chemical industry. Thus, the two sets of words, "national defense" and "chemical industry" can be considered practically synonymous.

Now I am only a neophyte in the chemical business. My profession, up until seven years ago, was the Army. I now have the good fortune to head a company which includes, among its diversified activities, many chemical operations. Like myself, however, my company is also a neophyte in the chemical industry in comparison with the parent companies of Mr. Ward, Mr. Doan, or those of many others here. No one in the Koppers Company can look back to 1802 when DuPont's first small powder plant went into production on the banks of the Brandywine River in Delaware; or back to 1888, when a lad named Herbert Dow put to good use the idea of obtaining bromine from an abandoned gas well at Canton, Ohio. Although some of our company's activities date back to 1837 and although one of its divisions has supported our armies since the Civil War, the company's chemical operations date back only to 1907.

But look at all these organizations today — they exemplify the American spirit of free enterprise, ingenuity, and mass production. All of them started as the brainchildren of a single person or of small groups, but today they are among the leaders of a 22 billion dollar industry—the American chemical industry. As America has grown, the chemical industry has grown. As America gained its place as a world power, so did the chemical industry. Just as today America is recognized as a world leader, so is this industry—for its imports no longer exceed its exports.

From personal experience I know what the chemical industry means to the military. Let's take the individual soldier for an example. From the very first day he enters the service, when he gets his first shot of vaccine, his life is influenced by chemicals in one form or another. His clothing, his equipment, his weapons, his physical well-being, are all dependent upon the American chemical industry. And should he be hurt, whether in training or in combat, new biochemicals have increased his chances of a safe and speedy recovery.

When we became embroiled in World War II, both the military and industry realized fully that the chemical industry was the foundation to military expansion in every field from the basic equipment of the soldier to the most complicated fire control instrument, battleship or airplane.

Picking three items at random—sulfa drugs, bugles and Napalm—let me cite them as examples of what chemicals meant in the winning of the war.

GENERAL SOMERVELL

Following 1937, when the extraordinary therapeutic value of sulfanilamide first came to the attention of the medical profession, a vast research program covering the new drugs was carried out, both by the military and by private industry. Serious problems were involved.

Finally, one Saturday afternoon, a group of commercial production and research men from Monsanto found the answers. Test samples, made over the weekend, looked good. Within six days the Surgeon General had tested the new form they had developed and given his approval. Within a week the re-worked product was being shipped to the Armed Forces. Every soldier's first aid packet soon contained a small envelope of sulfanilamide. How many lives it saved is hard to say, but the figure was enormous.

Those of you who have served in the Army have your own recollections of bugles. They are, as you know, a much-used item. They have a different sound at reveille and at mess times. In May of 1942, as our Army was expanding rapidly, there was a need for 200,000 instruments. But the bugles required the finest virgin brass for manufacture. Since brass is an alloy, three-fourths of which

AND NATIONAL SECURITY

President, Koppers Company, Inc.

is copper—and copper at that time was critical—the Quartermaster General had a problem.

Two weeks later, probably the most surprised man in Washington was the best bugler in the capital—a member of the Army Band—when handed a bugle produced by Mills Plastic Products. Doubtfully he put his lips to the instruent, expecting only to evoke myriad squawks. Instead, the plastic instrument blew easily, the notes were crystal clear, and the tone perfect.

There is another little point to the story. The Army at that time had a very reserved opinion of plastics—they were all right for costume jewelry, cigarette holders and such—but there was skepticism as to their value for Army equipment. The plastic bugle did the selling, and before long we had plastic mortar shell fuses, helmet liners, canteens and a wide variety of other items.

The third example is Napalm.

Flame warfare is nothing new. Even the cavemen knew that dumping hot coals on the head of his neighbor was an effective way to keep him from walking off with his wife. But it has been only in the last ten years that it has reached the stature of being a basic weapon owing to the development of Napalm. Today, in Korea, every infantry company attacking a hill takes along a portable flamethrower or two, or looks to a tank-mounted flamethrower, for added help in subduing the strong points. Whole mountains have been engulfed in flames from airplane-dropped bombs as a softening procedure before an Infantry attack.

In World War I, both the Germans and the Allies made several attempts to use gasoline as an offensive weapon. Their attempts were crude, and the results ineffective.

The Chemical Corps, working with a number of companies in the chemical industry, started experimenting with the use of chemicals as a gasoline thickener. After several unsuccessful attempts, the industrial chemists who were cooperating with the Corps, compounded the correct mixture of coconut fatty acids, oleic acid, and naphthenic acid. The result: Napalm—the "nap" for naphthenic acid and the "palm" for the coconut fatty acids—which could turn gasoline into a thin or thick jell. This gives us the effective weapon we have now.

Today, industry is continuing to answer the problems of defense with dispatch and through coordinated effort. Proverbially "the squeaky axle gets the grease," but because there have been few chemical bottlenecks, and critical chemical shortages have been overcome to a large extent, we hear little about either the troubles or the triumphs of our chemical industry's national defense effort. In the past 35 years, our chemists and industrialists have won chemical independence for the nation. They have moved the world's "chemical center" from Germany to United States. They won it independently, without bureaucratic guidance, military control, and for the most part without federal subsidy. And they won it so completely that the infinitely greater chemical demands of the last 12 critical years have been met quietly and efficiently.

The principal exception to this statement is the development of the atomic bomb and other applications of atomic energy. Whether this is primarily chemistry or physics is beside the point. I well remember the day when Conant and Bush came to me with the request for the development of the bomb and for the Army to assume the responsibility for the direction of the project. What happened after I gave the green light to this proposal is history familiar to you all.

In spite of some so-called impossible specifications, the Army and the Navy and the Air Force are continuing to obtain from the chemical industry almost all they want. This position was not created overnight, nor in a single decade. I have mentioned that the key to a strong national defense is going to be "sustained effort." Major General E. F. Bullene, the Army's Chief Chemical Officer, once included in a speech this sentence, "Our nation might well take as an example of the results of sustained effort, today's position of the chemical industry." Those familiar with the achievements of the industry will heartily concur with him.

You have been given an excellent summary of the history of America's Chemical Industry. It is well to note here, however, that the four years of the Civil War resulted in a 500 percent chemical production expansion, as much as followed in the 50 years of peacetime growth to 1914.

Some of you here must remember the shock to our economy when, in 1914, the outbreak of the war in Europe cut off imports of dyestuffs, potash, cyanides, medicals, and many other organic chemicals. In addition, the introduction of chemical warfare as a major activity in World War I was a direct challenge to our chemical industry. How well this challenge was met is indicated by the fact that at the end of the war our production of chemical warfare agents was four times that of Germany, and approximately equal to the combined production of France and Great Britain.

The chemical industry more than tripled between 1914 and 1919 and began to assume its present stature.

We could not have fought World War II so successfully without this new chemical production of the preceding 20 years. Despite the tremendous peacetime capacity, World War II nevertheless speeded chemical expansion by another 300 percent in the first four years. Since the opening of hostilities in Korea, chemical expansion is again following the pattern of previous war years.

There is one point regarding today's production that is not generally realized, however.

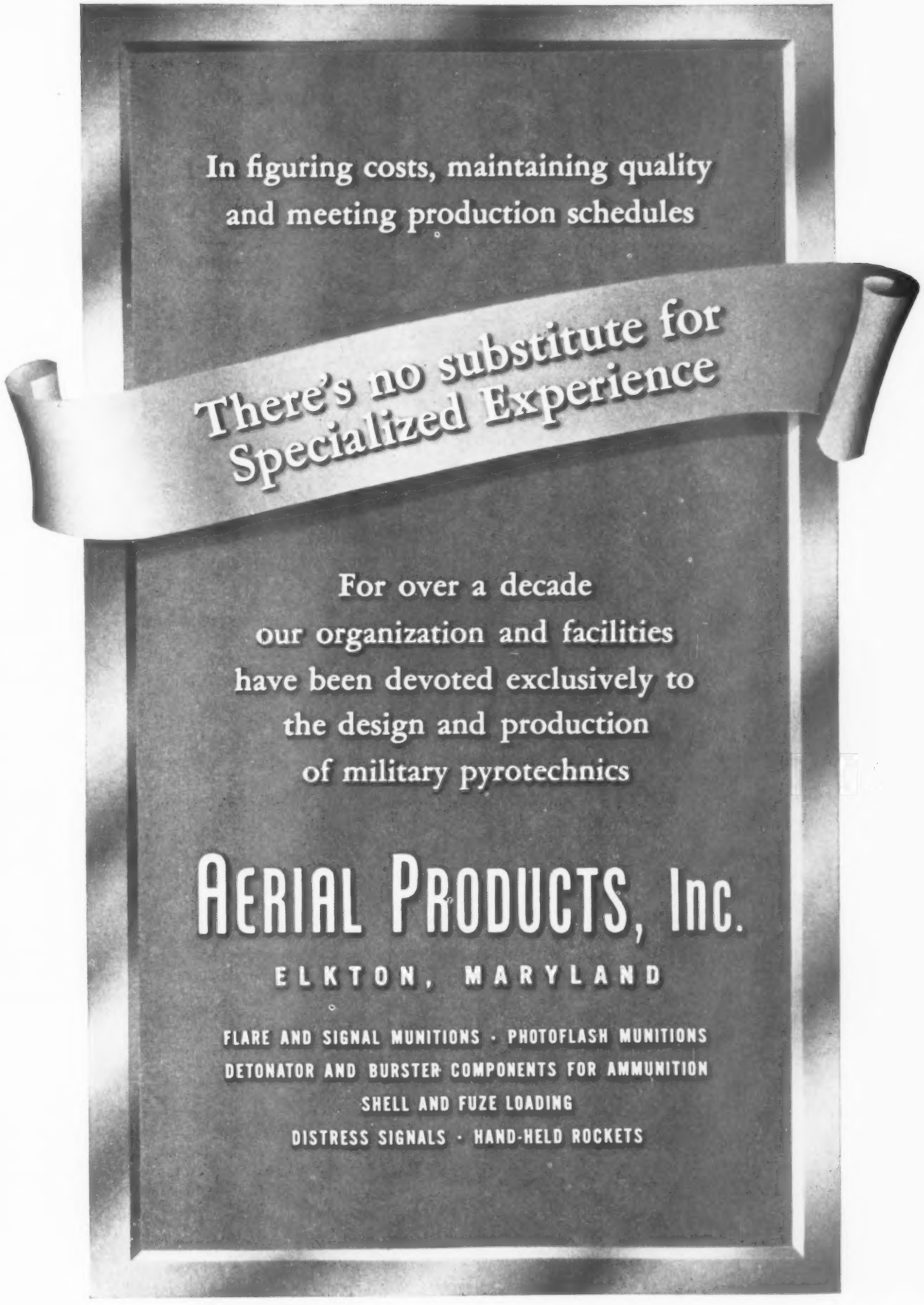
There is a basic difference between today's expansion of the chemical industry and that of World War II. During the war, the expansion was made almost entirely at taxpayers' expense, while today it is being done with private capital. Contrasted with the 17 billions of dollars spent on all industrial expansion during the last great war by the government, in which chemicals participated, it is safe to say that at present the government—disregarding the money spent for modernization and machine tools—is not spending more than 100 million dollars for new government plants. Yet the production of the entire chemical industry has, in the past two years, increased from 20 to 25 percent. This is a building of industrial capacity to support both a long military mobilization as well as to sustain a civilian economy at a reasonable level.

In any discussion of the chemical industry and national security, chemical warfare also must be considered. I mean the actual use of chemicals as such against personnel, materiel and installations.

When we think of chemical warfare, we think primarily of gas warfare—and some of us remember the terrifying effect it had in World War I. I propose to outline for you some of the thinking of authorities on the subject and to let you make up your own minds regarding any possible decision for using it or for outlawing it in future wars.

The public attitude today toward gas warfare is that it is loathsome—that gas shouldn't be used except in extreme retaliation. This is our present policy and has been since 1943. I imagine that if I should take a poll here this evening, I would find more people willing to use the A-bomb on the enemy than there would be backers of the use of toxic agents.

For some reason, not clear to me, our national thinking seems to accept certain methods of incapacitating or killing our enemies and rejects others as being "inhumane." Most seem to find it's quite all right to blow their heads off or maim them for life with bullet or bayonet, to eliminate them by blast or the horrifying effects of atomic disintegration, fry them in napalm or boil them in oil. Others fail to find those methods of warfare more humane than the use of gas which has been adopted by some of our states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as the most merciful form of execution. If our national existence is at stake, perhaps there must be some modification of these distinctions.

There are qualified students of the art of war who point out that here, within our grasp, is a weapon that can be a substantial factor in shortening any future conflict in an economic and effective manner.

These experts do not spin fantastic stories about mysterious chemical weapons of utter annihilation. There are none —but there are more lethal and dangerous gases than have hitherto been used in warfare. Their advocates maintain that toxic agents are good support weapons which, when used judiciously and properly in coordination with the other commonly accepted means of war, can shorten any action with a great saving of lives, property and money.

Most certainly, our most probable foe in any future war would not hesitate to use gas or any other kind of warfare if it would offer a direct military advantage and the risks of retaliation involved in its use could be overcome. We, therefore, must ask ourselves the question: Should we use it if we find the suitable situation?

Although most regard the Germans as responsible for introducing this method of warfare, we can find mention of it down through history. The accounts of the ancient wars of India in 2000 B.C., for instance, mention "fumes that caused slumber" or "prolonged yawning." During our own Civil War, ideas were entertained for the use of chlorine as a weapon. We like to think that it was humanitarian considerations that held back its usage. In reality, however, it was lack of knowledge of the technique of how to make the gas a controllable weapon, as well as lack of production resources, that deterred its use.

World War I saw the advent of gas in modern warfare as a prime weapon. Thus, since gas was not used in World War II, it is to the first great war that we must turn for most of our facts and figures regarding its economic aspects and the consequences of its use.

What are some of these facts? First, gas caused more than 70,000 or slightly more than 31 percent, of all our casualties in the AEF. This figure becomes astounding when we consider the facts that no airplane-dropped gas bombs were used in that war; that less than 10 percent of the German artillery shells were filled with chemical agents; and that the Germans never had more than 6,000 special gas troops in being at any one time.

Second, those who advocate the use of this weapon point out that although gas put men out of action just as effectively as did bullets, many of those casualties are living today. Only 2 percent of the American gas casualties died as a result of being gassed. On the other hand, the death rate was 25 percent for wounds received by means other than gas. Thus a soldier had 12 times better chance to survive a gas attack than he did if wounded by shells, shrapnel or bullets. The ratio of deaths to wounds was greatly improved in World War II and with the new medical developments of the past few years, the number of lives saved will be even greater. The losses are, however, still impressive.

Pointing to these facts, some military experts, who know that economy in men and munitions is a major factor in fighting any battle, declare that the use of gas munitions should also be a major factor in any study of the dangers that beset us. For instance during the closing months of World War I in 1918, gas ranked first among all of the military agents in the production of non-fatal casualties, and second in the production of all casualties. It took about 60 pounds of mustard gas on the average to produce one casualty, whereas approximately 500 pounds of high explosives were expended for each man wounded. The average was one casualty to 500 rounds of rifle and machine gun fire. No statistics are available since World War I as gas has not been used.

Once again let me say that these figures are unpleasant to contemplate, but so is war in any form. If they are correct—and they were compiled from official combat records—it would seem that those among the military who advocate the use of gas warfare may, in reality, have a point when they claim that it accomplishes immobilization of men—a major objective in any war—with fewer total casualties than explosives and at a lower cost.

So the question is: Where do we draw the line in the use of weapons available to us? And still more pertinent is the question: Where will our enemies draw the line in the use of weapons we know are available to them? The problem of retaliation in kind is important, perhaps controlling.

Only last week, Val Peterson, newly-appointed Federal Director of Civil Defense, announced that Soviet scientists are known to have developed nerve gases. They are new odorless, tasteless gases which resemble tear gas in their ability to render a human being helpless to do his work. Some of these nerve gases are effective in destroying the enemy's will to resist. Other related gases are capable not only of immobilizing personnel, but of causing permanent physiological damage. Are we to believe with infantile trust, that Russia will not use such gases when it will serve her purposes? Knowing the full destructive forces of these agents, should we not develop the instruments of detection, antidotes, and counter-measures, including retaliation?

In discussing the chemical industry, and its relationship to national security, as I have done this evening, I have not intended to minimize the importance of any other element of our total manufacturing and productive capacity. Together, these elements form a balanced and effective whole.

Our country's immense industrial capacity and agricultural production—unmatched by any other nation—provide our statesmen, as well as our military strategists, with assets of tremendous proportions. It is these great resources which counterbalance the relative lack of available manpower in comparison with that available to the Russians.

For our great assets, we should often, and with deep humility, praise and give thanks to our founding fathers for their wisdom in endowing us with the private enterprise system. Only in the climate of this unfettered economic system could our native ingenuity have created the vast industrial prowess that today so markedly increases our combat efficiency and effectiveness.

Fortunately, the chemical industry and its scientists have not laid down their test tubes, nor permitted their reactors to become idle since VJ Day. New products, as well as new processes, using more available materials, are being born with surprising frequency.

When I reflect on the vast American production of chemicals—never before equalled in history—and its relationship to our national security, I draw justifiable comfort from the fact that the chemist views the present products of his industry solely as "building blocks," —"building blocks" for better items for the future. The entire industry looks forward to the future and not backward to the past. And this dream constantly is being given substance through the vast scientific effort represented by this industry's research program which you have discussed earlier today. The inexorable march of the chemical industry toward new scientific horizons is of immeasurable importance to our security.

This technological superiority — so adequately exemplified in the chemical industry—combined with our nation's production supremacy, should make a potential aggressor pause. It is one of the foundations of our national security.

It is not enough, however, for us to reflect with pride on these accomplishments, outstanding as they are. If the military are not asleep in the face of our present peril, and I am sure they are not, they are busy thinking of more and better ways to win a decision on the battlefield. They realize that if they had

(Continued on Page 64)

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(Continued from Page 48)

attempt to build simultaneously a considerable number of large experimental power reactors, other than those for naval ship propulsion or other national defense purposes. For these immediately needed, special purpose units, a development and building program of the "crash" type is undoubtedly indicated.

But have we anything to gain by attacking atomic-electric power production on a crash basis? It seems to me the answer is "no." I question very much whether a crash effort can greatly reduce the time required to develop a sound industry, because I believe so strongly in the necessity of developing a favorable "climate," which takes time. A crash effort could conceivably give rise to such discouragement as to the economic soundness of the project that actual delay might result.

My feeling would be different if, for example, we could foresee a possible 50% to 75% reduction in the cost of electric power due to using atomic-electric power plants; or if we were very short of other fuel, or did not have means of expanding our power facilities efficiently and economically. In other words, I see no need to get hysterical about the development of atomic-electric power.

Please understand I am not by any means advocating that we stop or impede scientific and technological development. Rather, I am urging that we proceed on the basis of an orderly, well-thought-out program, with due regard for conservation not only of money, but of that much rarer commodity, scientific and engineering manpower.

American industry has carried forward in the past many developments of great magnitude, bringing outstanding benefits to all of us. I am confident that, given reasonable freedom of action, it can successfully develop an atomic-electric power industry.

In order to permit American industry to work on this development program in a normal, orderly fashion, some changes in the Atomic Energy law seem desirable. I hope that the Atomic Energy Commission and the Congress will soon begin to consider thoroughly steps which might be taken—without in any way jeopardizing national security of course—to relax some of the stringent restrictions in the present Atomic Energy Act. An evidence of some activity looking toward this end will I think greatly stimulate industry's interest in the whole atomic energy project. From recent publicity, it is apparent that the Commission and the Congress are giving this matter serious attention.

As to the ultimate effect of the peacetime uses of atomic power, one can only guess. As I said previously, I believe nuclear fuel will prove a very welcome addition to our fuel reserves. I think it will make electric power available at lower cost in areas where transportation of combustible fuel is expensive. It will be very valuable in certain special uses, as for powering submarines, other naval vessels, and ultimately commercial ocean vessels. It may prove useful on military aircraft, although the application problems here are difficult.

In the foregoing I have not attempted to explore the uses—and they are many—of the radioisotopes which the atomic piles can provide in such quantities; nor of the tremendous quantities of available radiation, which bids fair to be useful in chemical processes, in food sterilization, and in other ways. These applications seem to me to be somewhat outside the scope of this paper.

Let me close this rambling and too long discourse by saying that I am optimistic as to the benefits which the use of atomic energy in industry will bring to mankind in the rather long-term future, if we have the patience to avoid becoming discouraged by the many time-consuming difficulties which we are sure to encounter on the road of progress. Equally surely, we shall overcome them.

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(Continued from Page 36)

it was activated in June, 1951. But, as the school's 15 classes under First Lieutenant John Vestal, its commandant, will testify, perfection is never achieved. No matter how well a candidate performs his duty, the highest compliment he will ever hear is "that's good . . . but you can do better."

At the end of five weeks of training at the school the candidates report to one of the four RTC basic training companies for three weeks as acting non-commissioned leaders. But they are still under supervision of the regular cadre and company officers, so there is no letup on pressure. Candidates are continuously weeded out until their last Saturday, graduation day, after which many quickly qualify as non-commissioned officers, and are better prepared for Officer Candidate School.

"The eye of the master fatteneth the horse" is the guide for instructors and leaders at the RTC, and adherence to the motto keeps the level of training high throughout the center. This, coupled with the instruction to the administrative personnel of the RTC for more of "a place for everything, and everything in its place" has made the RTC a smooth-functioning organization.

The training program of the RTC is not cut from a single mold and then repeated. There are constant additions, corrections, and revisions to training schedules, which keep both instructors and trainees fresh and alert.

Graduates of the basic training program and of the Leaders' Course at the Chemical Replacement Training Center leave Fort McClellan well-qualified soldiers, thanks to the hard training under the supervision of qualified, combat-experienced officers and enlisted cadre.

CHEMICAL WARFARE AGAINST POPULATION A POSSIBILITY

Nerve and mustard gases, which affect the respiratory system, are most likely to be used in a possible chemical warfare against the civilian population of the United States.

This opinion was expressed in New York recently by James H. Defandorf, Ph.D., Washington. Dr. Defandorf, consultant in biological warfare for the Federal Civil Defense Administration, spoke at the Waldorf-Astoria as a member of a panel on civil defense at the 102nd annual meeting of the American Medical Association.

"The respiratory system is particularly vulnerable to the action of the nerve gases, which, by attacking a protective enzyme system of the body, are toxic in concentrations so small that they offer a real threat to the densely-populated areas of this country," he stated. "The well-known persistent action of the mustard gases makes their large-scale employment also a possibility.

"Defense of the civil population against chemical attack must be based primarily on protection of the respiratory system."

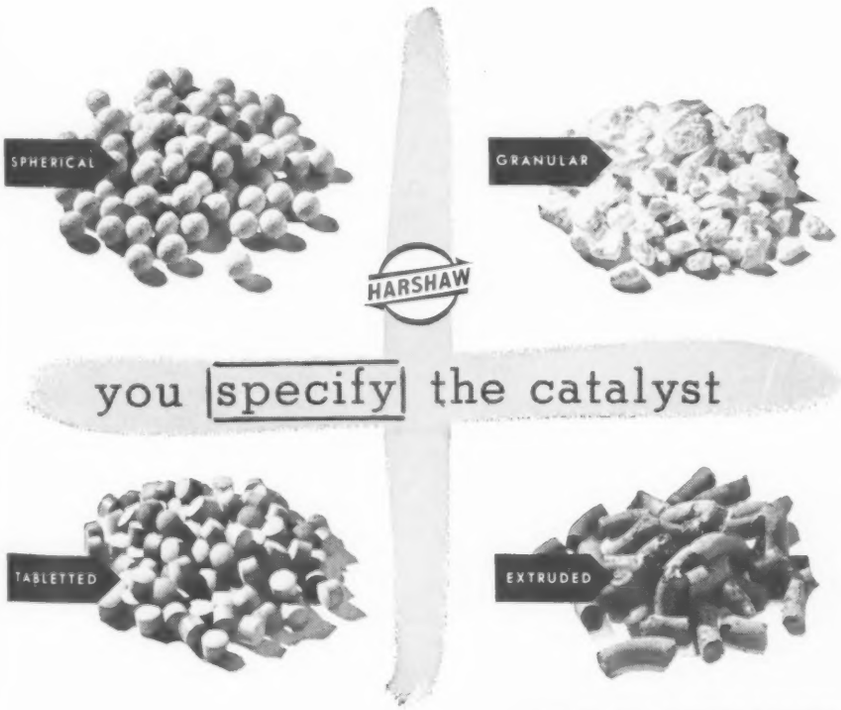
According to Dr. Defandorf, this best can be accomplished by means of individual gas masks or the use of protective shelters for individuals or groups, with gas masks the means of choice.

"Present planning is, therefore, mainly directed toward the provision of suitable protective masks for the citizens in critical target areas," Dr. Defandorf pointed out. "These include special masks for rescue workers and firemen, and for wardens, medical personnel, etc., and inexpensive, mass-producible masks for the rest of the population. It is not deemed essential to provide masks for the population of small urban or rural areas."

A duty or organizational type mask for those who have to work in contaminated areas has been developed by the army to the stage where procurement can be undertaken quickly when the need appears imminent, he stated. The civilian protective mask is being developed under a chemical corps contract, and procurement procedures could be instituted quickly, he added.

In the full planning for defense against chemical attack, the main problems are those concerned with warning, detection and identification, respiratory protection, decontamination, and preventive and definitive treatment following exposure, he said. However, he added:

"As it is very unlikely that advance warning will be possible, the establishment of a separate warning signal is not believed to be practicable. Procedures for detecting attacks and identifying agents have been devised or are under development by the Armed Forces, but have a security classification and presently are not available at state and local levels. Decontamination procedures have been devised."



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PROCUREMENT PROCEDURES

(Continued from Page 51)

experience, and in fairness to all, the following tabulation is shown on the replies to this question:

8 said it took too long to get the changes made
7 had very good experiences in getting the changes
6 had no experience in this field
5 found it difficult to get the changes made
3 found the agency reluctant to make the changes
1 found the change tough to get because of the lack of qualified personnel on the part of the agency
1 had just fair experience along this line.

Question Number Seventeen was, "What effect did engineering changes originating from the government have on your contract?" The replies to this were varied, and again a tabulation is set out, showing the replies to this question:

8 had no experience along this line
7 said the changes caused expensive delays
5 said the changes caused delays in meeting delivery schedules
5 said the changes had no vital effect on contract
2 said the changes caused delays but improved the end item
2 said the changes helped expedite contract.

On Question Number Eighteen, "What has been your experience regarding prompt payment on the contract?", 44.4% said their payment experience was very good; 18.5% said it was fair; 14% said it was satisfactory; 3.7% said that it could be better; 6.6% said it was bad.

Question Number Nineteen was divided into two parts. Part one was, "What has been your experience regarding price increases on components, and their effect on the total price of the item contracted for to the government?" Only seventeen firms answered this part of the question, due to their particular situations. Following is the tabulation of the replies received:

8 had no experience
3 said the only increase was due to engineering changes
3 said the price increase on components increased their manufacturing costs
1 said he absorbed such increases
1 said he required firm prices from subcontractors
1 said he required an escalator clause downward, from his subcontractors.

Part two was, "Do you believe that the government was fair in the consideration given your request for a price increase?" A percentage breakdown of the replies could not cover some of the qualified answers, and again we show the tabulations of replies as they were received:

7 had no experience
7 said yes
6 said the government was not fair
4 said the government was reasonably fair
3 said the government would not allow increases
2 said no increases were requested
1 said he had decisions both ways, fair and unfair.

Question Number Twenty was, "What is your opinion of mobilization planning in the light of the post-Korean situation?" Perhaps we were a little eager in phrasing this question, but we must plan ahead, and in that light we framed the question. We believe that a study of the following replies speak for themselves:

10 said it was very necessary
4 expressed need for better planning
3 said present program was meaningless
3 said present program was inadequate
2 doubted if any planning was going on
2 felt such a program was most desirable
1 said make standby basis more desirable
1 said continuity of present producers should be covered.

Question Number Twenty-one was, "Under what circumstances would you prefer a government contract over normal civilian business?" Here are the replies of twenty-two firms that responded to this particular question:

7 said under no circumstances
4 said for patriotic reasons
3 said they preferred normal civilian profit
2 preferred civilian business
1 wanted government contracts only in case of outright war
1 wanted government contracts only so long as they would not hamper his civilian business
1 will take government contracts when small business gets a break
1 will take government contracts only if he can get a redetermination of price clause
1 will take government contracts on a cost plus fixed fee basis
1 feels the choice is immaterial.

Question Number Twenty-two was, "In the event that you were an unsuccessful bidder, what factors would you say caused you to be unsuccessful?" Here is a full list of the replies to this question, and it is interesting to go back and study question 7B against these replies:

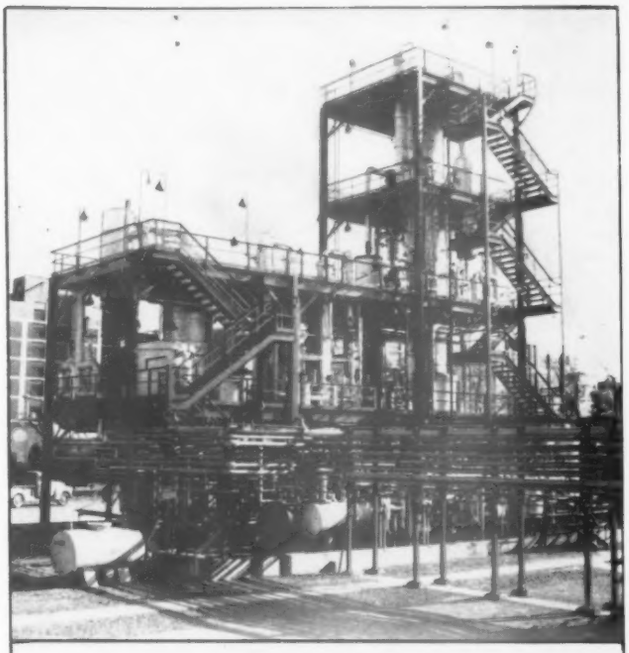
9 were unsuccessful on price
3 unsuccessful on labor rates
2 unsuccessful for lack of specialized machines
2 blamed a low bidder desperate for work
2 blamed an impossible delivery schedule
2 unsuccessful because specifications were not clear
2 blamed unusual specification requirements
1 blamed incorrect cost
1 unsuccessful because bid time was too short
1 blamed the unrealistic prices of successful bidder
1 did not have the necessary equipment
1 figured the job on past experience and lost
1 felt he did not have legitimate manufacturing competitors
1 blamed lack of "know-how"
1 was unsuccessful because he deviated
1 blamed evaluation of lowest responsible bidder
1 unsuccessful because of high freight rates
1 blamed general competition.

This survey shows where we in industry have problems, and whenever industry has been shown its weaknesses, it is the tradition of the American way to bolster our weakness.

To the Military, the survey shows where they are strong and where they need direction. We all recognize that the policies and programs of the Military originate in Congress, and if those policies and programs are outmoded, then Congress should realize that we are not shooting cannon balls as we did at Vicksburg, but we are fighting a war in a jet and atomic age and the policies and programs must grow up and meet this new era.

In the majority of cases the man who is doing business with the government and the man who wants to do business with the government recognizes that this same government is the largest business house in the world but he cannot understand the complexity of that business house. So to the Military we say, reach out and lend this contractor or potential contractor a hand, and supply him with tools and a program in keeping with the age in which we are living. If government specifications are complicated and confusing, revise them and make them understandable. Where government inspectors are having problems, perhaps a higher civil service rated employe could handle the situations that arise more adequately and not cause the long delays that industry is experiencing.

The tabulation shows the way for both industry and the Military, our strong points and weaknesses. It is industry's opportunity to serve without uniform, and the Military's opportunity to help in receiving the products of these industrial soldiers.



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MANPOWER

(Continued from Page 42)

a marked extent the faddism or the popularity race for certain projects which has been exemplified by the competition in guided missiles and certain other activities in the past few years. I believe that stronger civilian advice would tend to minimize that.

TECHNICAL MANPOWER PROBLEMS ABROAD

By Major General William N. Porter, Retired

Chairman of the Board, Chemical Construction Co.

The United States is not alone in having a shortage of technical manpower; such problems are world-wide.

I have recently returned from Europe where I had an opportunity to observe the situation in engineering companies similar to the one to which I belong. Our company is engaged also in the design and erection of plants in many countries outside of Europe so that a certain amount of knowledge of manpower conditions comes to me from our people at these plants.

The manpower shortage takes different forms in different countries. In certain highly developed countries, the shortage of skilled personnel is sometimes only university graduate level and sometimes on the foreman level.

I had a chance to talk with some very prominent British engineers about this matter. The English universities graduate only some two hundred chemical engineers annually compared to some thirty-eight hundred graduated from American schools and universities. Since each of the British engineers must give two years to military service before graduation or after, military demands make a serious inroad into that class of personnel.

In addition to the world-wide reasons for shortages, the British cite one additional: Generally speaking, the pay is not attractive, nor is the status of chemical engineers sufficiently high to attract a great number of youngsters. The pay of a graduate chemical engineer in his early years is about three hundred pounds, something less than nine hundred dollars a year. As you all know, a man with a diploma in chemical engineering in this country can usually walk into an American company and get something around three hundred fifty dollars a month. In fact, if he does not walk in himself, some personnel scout will probably be out looking for him.

Chemical engineering as a profession has never reached the status in Great Britain that it has in the United States since beginners are not well-paid and most young men in the middle classes, from which it seems, generally speaking, chemical engineers are drawn the world around look for positions which pay better and where such long training is not necessary. In England, as in numbers of other countries, it is necessary to get the breadwinner to work as fast as is possible in more lucrative fields in order to bring more things into the depleted household budgets.

A recent article in "Chemical Engineering," from which I am liberally borrowing, states:

"Historically, British universities were slow to include chemistry in their curricula. University administrators used to feel that chemistry wasn't a proper subject for gentlemen. And—as a report on the history of Oxford University puts it—the students were distressed by the unpleasant laboratory smells.

"In search for remedies, Britain has reconstituted the Technical Personnel Committee which dealt so successfully with scientific manpower questions during World War II. The association of Chemical Engineers has suggested the introduction of part-time courses in chemical engineering in order to boost the existing crop of technical manpower."

In underdeveloped countries there is usually a large manpower pool, but even "basic" training is sadly missing. Here the training up to the "foreman" level may be the most important step to relieve at least temporarily the technical manpower shortage, since supervision, on the university level, can be provided either from outside or even from the country itself. For example, there is a surplus of university trained people who cannot be employed usefully because the trained middle level is inadequate in numbers.

Many attempts are being made to relieve these manpower shortages—government and private agencies are working in this field. Foremost is the International Labor Organization (ILO) of the U.N. which is trying to evaluate the problems of the individual countries by surveys and then decide upon the type of assistance needed. In many cases, it is a problem of classification and re-arrangement of manpower pools. This is particularly true in Western Europe. But migration, especially of highly skilled workers (displaced persons), to underdeveloped countries in Asia, Africa and Latin America comes into play here too.

Technical assistance by U.N. and U.S. agencies is more concerned with underdeveloped areas. Here the actual vocational training of the unskilled laborer is stressed and supervision is provided. Introduction of new and more efficient tools especially in agriculture helps to relieve shortages of manpower.

There are a number of private agencies and enterprises that come into the picture, particularly where production of food is involved. Predominantly voluntary and charitable in nature, groups such as CARE, American Friends Service Committee, The Christophers are among the most active.

American industry has provided a certain impetus to utilization of technical manpower by help in starting new manufacturing in countries like India. Here actual on the job training for skilled and supervisory personnel will eventually pay dividends in enlarged technical manpower pools.

I want to agree with Will Rogers who said once, "You know, we don't need more civil engineers; we need more civil conductors." As a matter of fact, we need both.

CHEMICAL INDUSTRY AND NATIONAL SECURITY

(Continued from Page 58)

this and that, victory would be more certain and could be won much faster. That causes them to dream of new devices for munitions, and to come to industry, specifically the Chemical Industry, with which we are concerned, with new and so-called impossible "specifications." Some that have been mentioned in previous discussions of this kind are a fuel for airplanes that won't burn when hit by incendiary bullets, lightweight materials that will maintain their physical properties at 1000° F to 2000° F, adhesives for metal to metal with bonding strength of the metals, flame proofing agents, preservatives, chemicals with so far unattained purity, non-inflammable lubricating and hydraulic fluids, less bulky, more stable and equally nourishing foods, waterproof and cold-proof clothing and many others which have received more publicity as well as some which are carefully guarded secrets. You may be sure our enemy is alert and may not regard such things as impossible. Perhaps if we are to survive we must accomplish the impossible. In the Army Service Forces which I commanded during World War II we used to have a motto, since widely quoted, "the impossible we do immediately; miracles take a little longer."

May we again do the impossible to win us victory in this and any war that comes!

But deep in our souls, we pray devoutly for a miracle in the minds and hearts of men, that peace, not war, may descend and remain upon this earth of ours.

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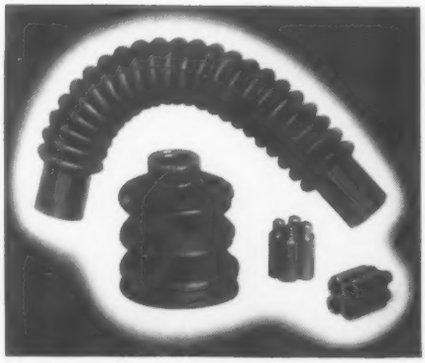

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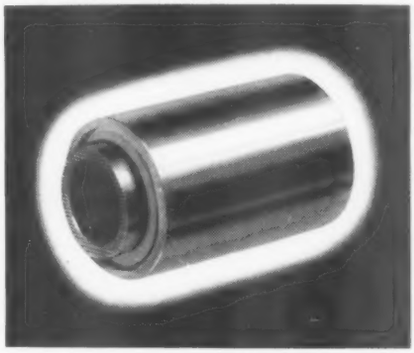

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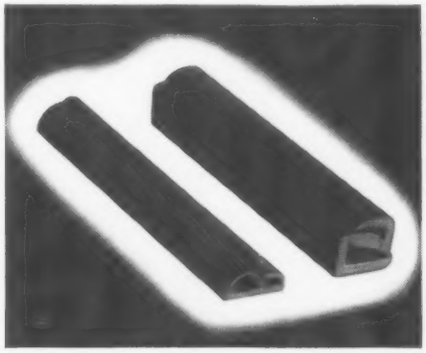

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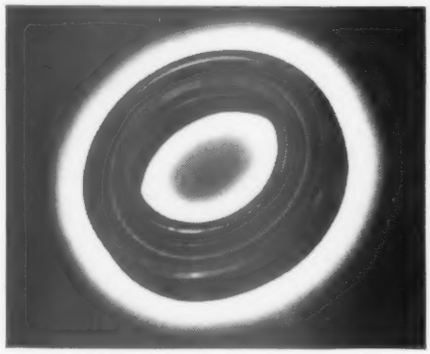

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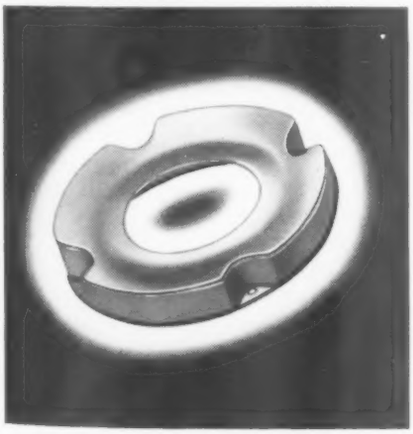

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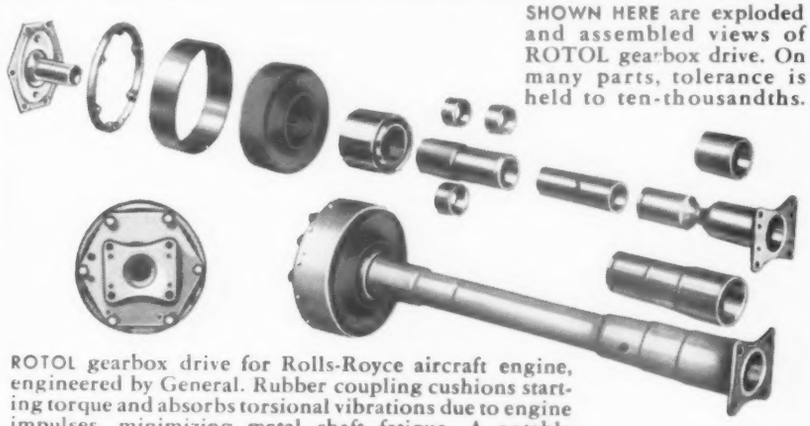

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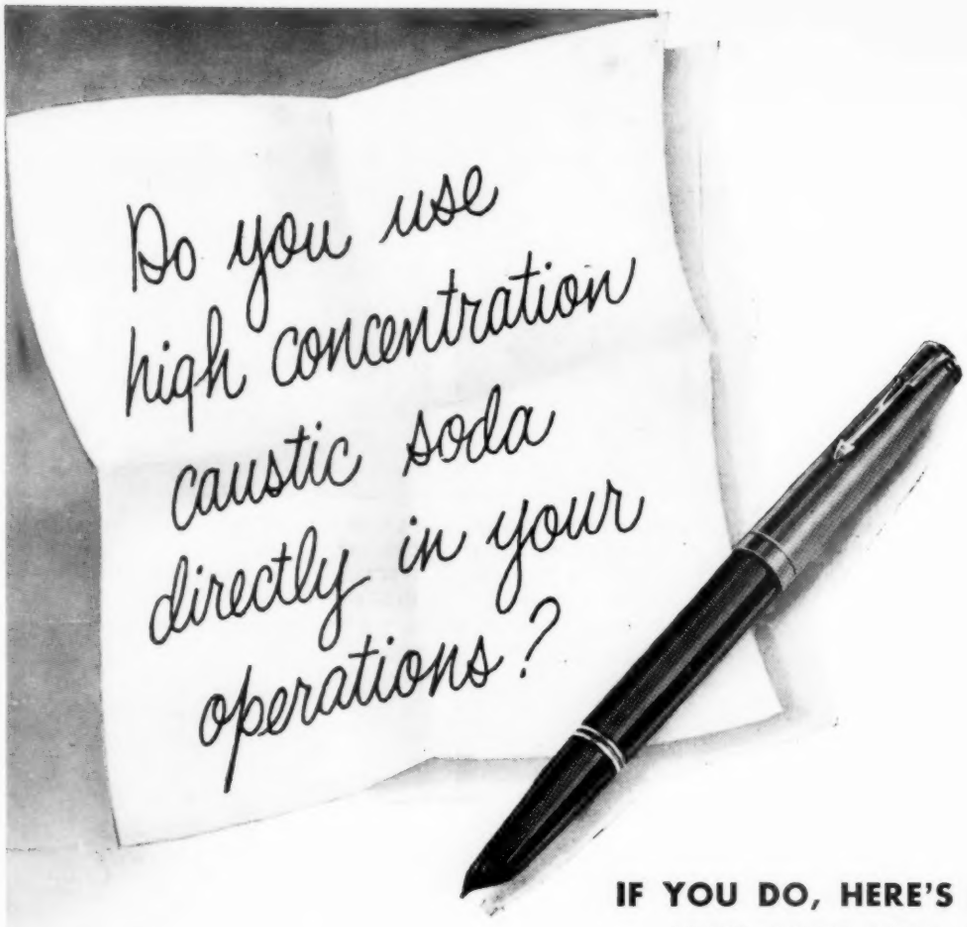

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